(b) Referring to the Ekamai Report (wherein it was assumed that the land of total road area be newly acquired) the percentage of land cost to the total construction cost is estimated by zone for elevated roads and at-grade roads.

(c) Table 11.3.6 was then prepared, which shows the percentage of land acquisition cost to total construction cost by necessity of land acquisition which is expressed in percentage of necessary land acquisition to total road area of a project.

It is assumed that land acquisition and compensation costs will be paid only for private land and not for public land such as right-of-way of roads and rails, river beds, and military land. However, it is noted that opportunity cost is considered for space that can likely be appropriated for other uses, even if the space is public land, in the economic analysis of the projects.

11.4 Project Implementation Period

The project implementation period normally covers the following activities; engineering work (conceptual design/detailed design), project bidding/evaluation/negotiation/approval, right-of-way acquisition/compensation, and construction. This study simplifies the project period as follows:

(a) Project preparatory period: includes engineering and right-of-way acquisition.

(b) Construction period: construction period include some engineering and right-of-way acquisition as well.

The following were taken into account in determining the period for project preparation:

(a) Two years period is assumed in general.

(b) One year is assumed in cases where the project scale is small, and none or very small land acquisition is required.

(c) Three year period is assumed in cases where land acquisition difficulty is expected.

To determine construction period, the following was considered:

(a) Reference was made to the current achievements and plans of DOH, ETA, PWD, and BMA.

(b) The construction period can be shortened by partitioning a project into sections, even if the project is of a large scale. Based on the achievements by various governmental bodies, a 2-3 year period is taken in general.

(c) However, a 4-6 year period is considered for road projects which include bridges (especially those constructed over Chao Phraya River), for those crossing over existing elevated constructions, and for those including widening of existing roads.

Table 11.3.6 Estimeted Percentage of Land Acquisition Cost[1/] to Total Construction Cost

Area	% of Recessary Land Acquisition Area to Total Road Areas (At-grade Main Roads)					% of Necessary Land Acquisition Area to Total Road Areas (Expressways)				
	100-75%	75-50%	50-25%	25-0%	0%	100-75%	75-50%	50-25%	25-0%	0%
CBD (Yaowarat/Bang Lam Phoo/ Silom)	500	250	150	50	0	150	100	50	15	0
Phayathai/Sukhumvit	250	125	80	25	0	75	50	25	10	0
Yannawa/Thon Buri/Lat Phrao/ Hua Mak	150	75	50	20	0	50	30	15	7.5	0
Bang Khen/Samut Phrakan/ Dao Khanong	100	50	25	10	0	30	15	10	5	0
Others	50	25	10	5	0	15	10	7.5	5	0

1/ including compensation costs

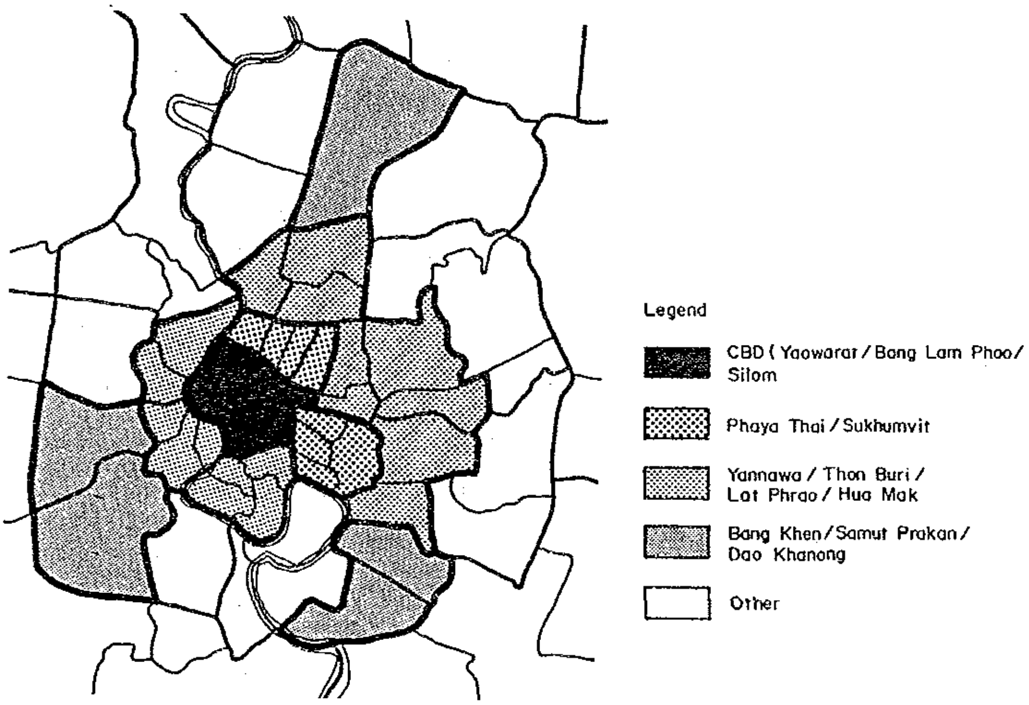


Figure 11.3.1 Classification of Study Area by Land Price Level

CHAPTER 12

IMPLEMENTATION SCHEDULE

12. IMPLEMENTATION SCHEDULE

12.1 Priority Setting of Road Projects

1) Methodology

This section discusses the development phasing and priority setting of the projects to maximize the benefits of the 2006 road network plan in intermediate stages. The following criteria was taken into account:

(a) Economic viability: Each project or package of projects was assessed from the economic viewpoint on the basis of "with" and "without" the concerned project in 2006 network plan. Benefits attributable to a project include only savings on vehicle operating cost, while the cost of the project includes construction cost, land cost, engineering cost and contingency. The B/C ratio was estimated based on the discount rate of 12%.

(b) Traffic aspect: This aspect covers traffic volume on a project, volume capacity ratio of links, and traffic volume per unit investment cost.

(c) Network configuration: Any single link is interactive with other links of a total network, especially in urban areas. Project scheduling should, therefore, take into account the role of a project in the network and its implication to other projects.

(d) Urban development: Transportation is only one of the many factors which will encourage desirable urban development. However, in Bangkok, development of a road has a strong impact on the urban development along the road making transportation a major development factor.

Taking into account the above, the projects, at first, were evaluated within respective sub-sectors such as expressways, at-grade main roads and bus-ways. Then the following factors were considered to program the project packages within the three planning periods of 7th (1991-1996), 8th (1997-2001) and 9th (2002-2006) plan periods:

(a) Financial constraints: Financial capability of Bangkok to invest in transport infrastructure will continue to be one of the critical constraints for the implementation of the projects. Although many large-scale projects are intended to be implemented by concession or BOT scheme, this does not in any way imply that the Government or Bangkok will be free from financial constraints. Based on the review of allocations to transport infrastructures in Bangkok, the estimate made in the STTR Study, and expected future economic growth, it is estimated that the level of available financial resources for the projects in the study area is approximately 250 billion Baht by the year 2006, which is roughly 3% of the estimated GRP of the study area. For each of the plan periods of the 7th, 8th and 9th, respective allocations are 70 billion, 80 billion and 100 billion Baht.

(b) Sector priority: This priority shall, in particular, deal with the issue of rail and road projects. The investment priority of rail transit projects shall be studied in the context of implementing the identified projects within the assumed financial limit, bearing in mind the large size of rail transit investment costs, and the effects rail transit projects will have on the entire transport project implementation schedule.

2) Expressways

The room for discussion on the priority ranking for expressways is limited, because a considerable size of the investments has already been committed.

The priority ranking was developed as follows:

(a) The first group of projects mostly comprises those already committed and on-going such as Second Stage Expressway System (x010), FSE - Don Muan Toll Road (x060), Bang Na - Trad Toll Road (x080) and Thonburi - Pak Tho Toll Road (x090).

(b) The second group includes Ekkamai - Ram Intra (x031) and those which will form a new circumferential system together with the completed links. Those are Thonburi - Bang Su - Ramkhamhaeng Expressway (x120 : x121, x122 and x123). In addition to the above, Soi Asoke Flyover (x170) and Bang Na - Samut Phrakan Expressway (x110), both extensions of existing expressways, are included to meet the pressing demand in their respective areas. With these projects, the Bangkok Expressway System will finally have a clear radial and circumferential network which also covers the area west of Chao Phraya River.

(c) The third group of projects will further strengthen radial and circumferential network depending on the estimated demand. An extension to the north (x060: extension of Don Muang - Rangsit Toll Road), an extension to the west (x100: Phet Kasem Expressway which will link the west directly with CBD and SSE), an extension to the south (x042: extension from FSE), a new link between the south and the southeast across Chao Phraya River (x041: extension of Ekkamai - Ram Intra), and an additional east-west link in the north (x071) are the projects included in this group.

3) Bus-ways

Scheduling of bus-ways depends on the development of the rail transit, especially LRT (Sky Train). Bus-ways are planned in order to provide dense segregated mass transit network in the city centre within the Middle Ring Road. Therefore, the bus-ways should be constructed so as to supplement the LRT.

The results of the economic evaluation and traffic estimates show that all the routes can attract sufficient traffic thereby effectively utilizing segregated lanes and indicating high B/C ratios. In view of the relatively low investment cost and expected immediate effects on the public transportation improvement, it is planned that the proposed bus-ways should be implemented in the early stages of the plan period; namely 7th and 8th plan periods starting from the internal routes.

Table 12.1.1 Estimated Traffic Volume and B/C Ratio of Bus-ways

Assume Project Group	Length (Km)	Ave. Traffic Vol: PCU/day, 2006	B/C Ratio
1) B041, B042	16.1	17.500	3.0
2) B051, B052	19.7	8.500	9.0
3) B091, B095, B096	35.2	7.300	3.3
4) B012, B014, B018	22.8	8.800	3.2
5) B062, B063, B004 B070	24.5	8.500	4.5

4) At-grade Main Roads

At-grade main roads were assessed from economic, traffic, cost-effectiveness and network viewpoints. The assessment criteria were developed by the study team and the results, shown in Table 12.1.2, will provide a guideline for the development.

Table 12.1.2 Evaluation of At-Grade Main Road Projects

Project Code	Length (km)	Project Cost : Economic (B mill.)	% of Land Cost	B/C Ratio	2006 Traffic Volume 000/day	2006 V/C Ratio	Traffic/Cost (Veh km/ B000)	Assessment: Economic	Assessment: Cost Effec-tiveness	Assessment: Traffic	Assessment: Network (Project Interaction)	Assessment: Overall
H011	38.3	1,337	19	X	30.8	0.3	7.0	-	A	B	A(-)	A
H012	48.7	1,183	26	X	83.0	0.7	27.2	-	AAA	A	A(-)	AA
H013	18.6	451	26	X	64.9	0.5	21.3	-	AAA	A	A(-)	AA
H014	33.4	4,342	7	X	75.4	0.6	4.6	-	B	A	A(-)	A
H021	12.6	437	25	75.2	66.3	0.8	15.2	AAA	AA	A	AA(071)	AA
H022	8.5	294	25	59.6	85.7	1.1	19.6	AAA	AA	AA	AA(-)	AA
H031	6.3	257	15	79.9	132.3	1.1	25.8	AAA	AAA	AAA	AA(X071)	AAA
H032	10.0	733	17	2.2	62.1	0.8	6.4	A	A	A	A(-)	A
H040	11.1	428	11	6.0	51.4	0.7	10.5	AA	AA	A	AAA(B052)	AA
H050	12.8	661	15	X	45.4	0.8	7.0	-	A	A	AA(B052)	AA
H061	18.2	638	28	X	78.7	1.0	17.9	-	AA	A	AAA(X121)	AA
H062	6.4	506	12	X	58.4	0.7	5.8	-	A	A	AA(-)	A
H070	4.6	303	33	X	79.8	0.8	9.7	-	A	A	AAA(-)	AA
H080	6.7	138	25	13.8	22.0	1.0	8.5	AAA	A	B	AAA(-)	A
H090	9.0	381	39	10.8	84.2	1.0	16.0	AAA	AA	AA	AAA(x121)	AAA
H100	1.1	57	49	82.2	91.2	1.2	14.3	AAA	AA	AA	AAA(-)	AAA
H110	1.7	2.077	4	11.3	84.7	1.2	0.6	AAA	C	AA	AA(-)	A
H120	4.6	73	25	8.5	93.4	1,0	46.9	AA	AAA	AA	AAA(-)	AAA
H130	9.8	'101	48	9.4	66.0	1.2	51.6	AA	AAA	AA	A(-)	AA
H141	12.8	442	25	34.3	91.7	1.1	21.1	AAA	AAA	AA	AAA(B012)(014)	AAA
H142	6.8	297	48	18.2	67.8	1.0	12.6	AAA	AA	AA	AAA(B012)	AAA
H143	6.8	566	18	15.2	67.4	0.8	6.4	AAA	A	AA	AAA(-)	AA
H144	13.0							AA	AA	A	AAA(-)	AA
H150	10.4	415	25	19.7	20.3	0.6	4.0	AAA	B	B	AAA(X011)	A.
H160	10.4	268	33	25.1	40.4	0.7	12.5	AAA	AA	B	AAA(-)	A
H170	12.4	410	25	33.6	74.0	0.9	17.7	AAA	AA	A	AA(-)	AA
H180	9.3	326	28	7.3	93.9	1.2	21.4	AA	AAA	AA	A(-)	AA
H190	10.0	285	15	9.0	32.2	0.4	8.9	AA	A	B	AA(-)	A
H200	1.6	139	72	77.8	113.8	1.4	10.7	AAA	AA	AAA	AAA(-)	AAA
H210	22.0	709	0	4.2	47.0	0.7	11.4	A	AA	A	A(-)	AA
H220	20.6	1,213	37	11.8	69.0	0.8	9.4	AAA	A	A	AAA(-)	AA
H230	18.8	1,005	37	X	87.0	1.2	13.0	-	AA	AA	A(X031)	AA
H240	6.8	193	15	X	68.4	0.9	18.9	-	AA	A	AA(B095)	AA
H250	3.2	165	48	4.1	69.6	0.8	10.9	A	AA	A	A(-)	AA
H260	15.3	401	32	37.7	69.8	0.9	21.2	AAA	AAA	A	AAA(X015)	AAA
H270	9.8	341	25	X	28.6	0.3	6.5	-	A	B	AA(-)	A
H280	19.8	521	15	X	53.1	0.7	16,0	-	AA	A	A(X110)	AA
H290	7.6	272	30	X	141.6	1.7	31.7	-	AAA	AAA	AAA(-)	AAA
H300	9.1	1,243	74	X	77.6	1.0	4.7	-	B	AA	A(-)	A
H311	4.7	282	55	3.5	97.4	1.2	13.3	A	AA	AA	AAA(X123)	AAA
H312	9.7	604	60	8.6	91.3	1.1	11.9	AA	AA	AA	AAA(X123)	AAA
H313	8.4	538	26	29.0	102.3	1.2	12.8	AAA	AA	AAA	AAA(X121,122)	AAA
H320	30.6	1,339	14	X	41.0	0.5	7.4	-	A	B	AAA(-)	A
H330	19.4	458	15	X	36.4	0.4	12.2	-	AA	B	AA(-)	A
H340	12.6	361	15	X	12.4	0.2	3.4	-	B	C	AA(-)	A
H350	38.1	1,249	15	X	87.4	0.8	21.1	-	AAA	A	AAA(X060)	AA
H360	(Interchange)											
H370	0.8	362	15	X	143.3	2.0	2.4	-	B	AAA	AAA(-)	AA
H380	5.3	343	33	X	28.0	0.3	3.5	-	B	C	AAA(B041)	A
H390	1.2	354	9	X	84.9	1.2	2.2	-	B	AA	AA(-)	A
H400	4.3	280	48	19.5	59.1	0.8	7.4	AAA	A	A	AAA(X012)	AA
H410	16.7	336	13	17.1	86.8	0.7	34.0	AAA	AAA	A	AAA(-)	AA
H420	8.3	2,371	3	7.2	107.8	1.3	3.0	AA	B	AAA	AA(-)	A
H430	6.7							AA	AA	AA	AA(-)	AA
H440	7.0							AA	AA	A	A(-)	AA

*: Mean B/C anlysis was not made, because they have been committed.
: Criteria of assessment is as follows:

(1) Economic

B/C ratio are:
AAA:10 and above
AA:5 - 9.9
A:1 - 4.9

(2) Cost Effectiveness

Traffic/Cost are:
AAA:20 and above
AA:10 - 19.9
A: 5 - 9.9
B: 1 - 4.9

(3) Traffic

Traffic volume and V/C Ratio are:
AAA:100,000 above or 1.5 above
50,000 above and 1.5 above
AA:50,000 above and 1.0 - 1.49
A:50,000 above and 0.7 - 0.99
B:50,000 less and 0.7 less

(4) Network

AAA:very important
AA:important
A:important but alternative link exists

(5) Overall

Implementation recommended for
AAA:short-term (7th plan)
AA:medium-term (8th plan)
A:long-term (9th plan)

12.2 Implementation Schedule

The implementation schedule was formulated based on the priority assigned to the road projects and further consideration of the following:

(a) Study of project specifics: The project period was broken down into engineering, land acquisition and construction terms.

(b) Estimated allocation of investment funds by National Plan Periods; 7th, 8th and 9th: The sum of the investments scheduled for each Plan Period should not exceed the estimated available fund by too much.

Implementation scheduling was determined as follows:

(a) Investment in rail transit projects will be mainly done in the 8th and 9th Plan periods considering the large investment size and implementation difficulties.

(b) Bus-ways, which require relatively small investments, will be implemented in the 7th and 8th Plan periods to meet the urgent improvement needs of public transport.

The implementation of a bus-way planned above the Saen Saep canal (B091 and 095) is expected at the beginning of the 7th Plan period.

(c) Additional expressways will be implemented in the 8th and 9th Plan periods, because the ongoing SSE alone consumes a sizable amount of funds.

The commencement of preparation works for a circular expressway (X121-123) and Asoke fly-over (x170) is allocated to the latter half of the 7th Plan period.

(d) Emphasis is placed on the investment in at-grade main roads and especially distributors. The completion of the outer ring road can be delayed.

Some main road projects are scheduled to start by the end of the present Plan period, both to alleviate the present traffic congestion and to provide a base for upper level structures like the expressway and bus-way.

12.3 Investment Programme

1) Periodical Investment Allocation Guideline

A guideline for the allocation of investment to the planning periods is established based on the expected future economic growth of the study area.

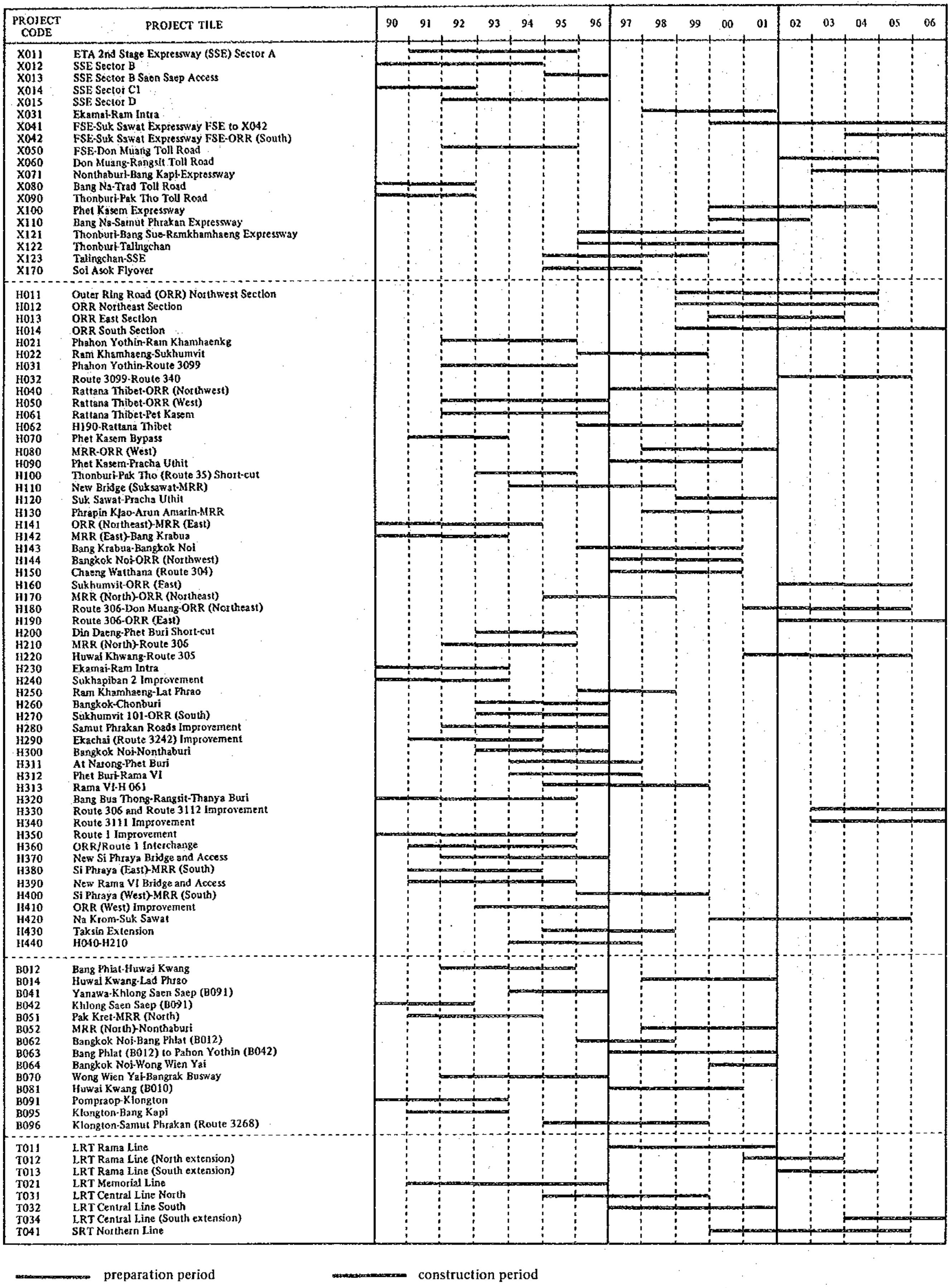


Figure 12.2.1 Implementation Schedule

As described in Chapter 6, BMR's economy is assumed to grow by 11.8%, 6.8%, and 5.0%, during the periods of 1990-1996, 1997-2001, and 2002-2006, respectively. Figure 12.3.1 shows the relative amount of GRP by year from 1990 through 2006. Assuming that the accumulated amount for the whole period is 100, those for the three intermediate periods are: 26.6 in 1990-1996; 31.7, 1997-2001; and 41.7, 2002-2006.

The distribution of the total investment costs of 240 billion Baht over the three periods by the GRP growth percentages is adopted as a guideline for the investment allocation.

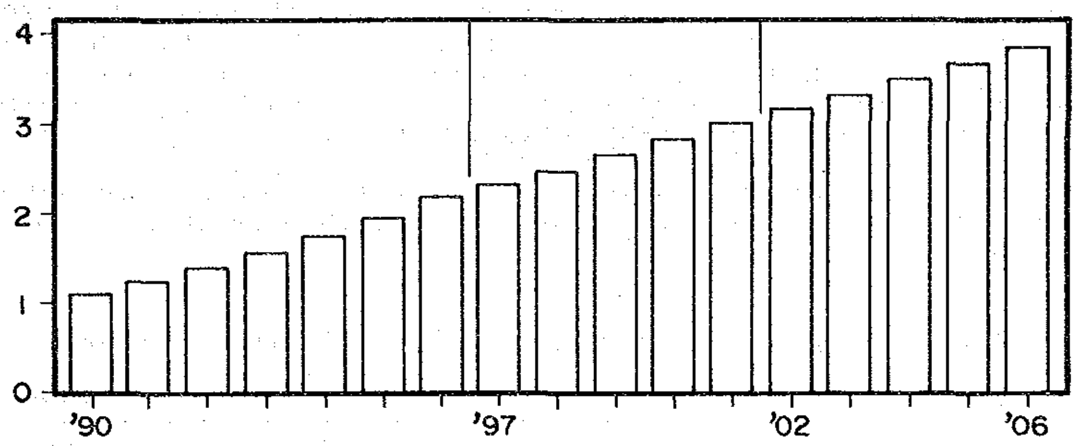


Figure 12.3.1 GRP Growth Trend (1989=1)

Table 12.3.1 Period Investment Allocation Guideline

	1990-1996	1997-2001	2002-2006	Total
Amount (billion Baht)	64	76	100	240
Composition (%)	26.6	31.7	41.7	100.0

2) Investment Program

Based on the implementation schedule, the investment amounts of each project are allocated to each year of its implementation period.

If land acquisition is needed for a project, the purchase of land is assumed to start one year before the start of construction work and to continue for the determined land acquisition period. This means that, if the land acquisition period is 2 years or more, construction work starts in the second year of the land acquisition and both the construction work and the land acquisition are carried out at the same time till the whole land needed is purchased. The land acquisition cost is allocated equally to each year during the period as described previously.

Design cost is assumed to be 30% of the total engineering cost, and is allocated to the year preceding the start of land acquisition or of the start of construction work if no land acquisition is required.

The cost obtained by subtracting land cost and design cost from the total investment cost is allocated equally to each year during the construction period.

Table 12.3.2 shows the investment amounts by facility by the planning period. The total investment costs amount to 240.3 billion Baht, of which 115.3 billion Baht (48%) is for the rail transit. Excluding the rail transit, the total amount of investment for the road projects is 125 billion Baht, more than half of which is for the expressway projects.

Compared to the guidelines shown in Table 12.3.1, the investment amount allocated for the period of 1990-1996 is higher by 7 billion Baht.

Table 12.3.2 Investment Amount by Facility by Period

(billion Baht)

Facility	1990-1996		1997-2001		2002-2006		Total	
	Amount	(%)	Amount	(%)	Amount	(%)	Amount	(%)
Expressway	30.0	(42.2)	20.6	(27.2)	20.0	(21.4)	70.6	(29.4)
At-grade Main Road	16.8	(23.6)	9.4	(12.4)	12.7	(13.6)	38.9	(16.2)
Bus-way	10.7	(15.0)	4.8	(6.3)	-	(-)	15.5	(6.5)
Rail Transit	13.6	(19.1)	41.0	(54.1)	60.7	(65.0)	115.3	(48.0)
Total	71.1	(100.0)	75.8	(100.0)	93.4	(100.0)	240.3	(100.0)

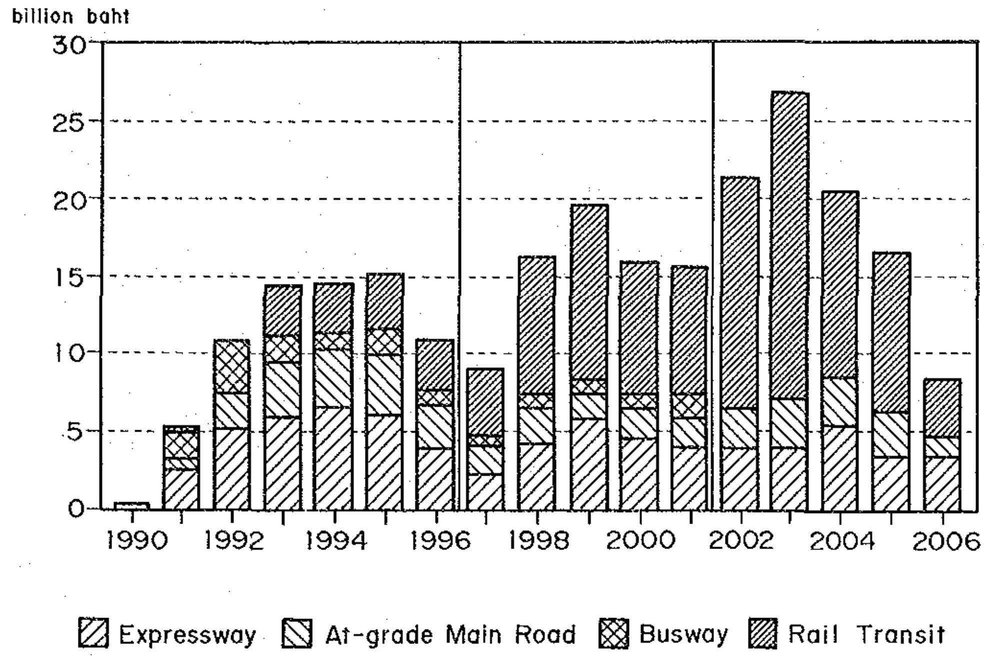


Figure 12.3.2 Investment by Facility Group

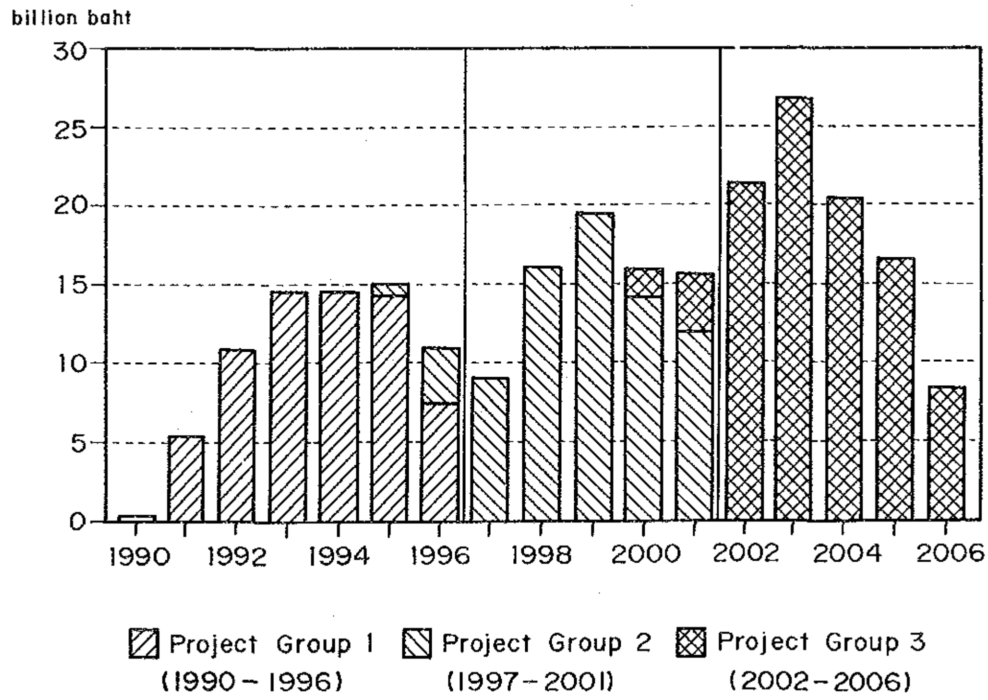


Figure 12.3.3 Annual Investment by Plan Period

CHAPTER 13

EVALUATION OF PLANS AND PROJECTS

13. EVALUATION OF PLANS AND PROJECTS

13.1 Evaluation Method

1) General

In this chapter, an economic evaluation of the proposed road masterplan is carried out based on the investment program described in the previous chapter. The road masterplan includes three types of projects: expressway, busway, and at-grade main roads.

The plan is evaluated from the following three points:

1. Masterplan as a whole
2. Projects by type
3. Projects by implementation period

For the evaluation of the projects by implementation period, the projects are grouped into three according to their completion year scheduled: Project Group 1, 1992-1996 (the 7th Plan period); Project Group 2, 1997-2001 (the 8th Plan period); and Project Group 3, 2002-2006 (the 9th Plan period).

It is assumed that the rail transit projects will be completed as scheduled by the Study Team. A case in which none of the above-mentioned projects, except the rail transit projects are implemented is regarded as the "without" case for evaluation.

The evaluation is made for a period of 17 years from 1990 to 2006. For a respective evaluation of the project groups, the starting year of evaluation is set for the first year of investment of each project group.

As evaluation indicators, the net present value (NPV), the benefit-cost ratio (B/C), and the internal rate of return (IRR) are calculated for the evaluation period.

2) Benefits

The benefits generated by implementing the road masterplan are assumed to be savings in vehicle operating costs (VOC), and expressed as precisely as possible in money terms as they occur during the evaluation period.

Savings in travel time costs (TTC) can also be expected. The means of measuring such costs, however, are rather controversial. For example, is travel time saving of all trips economically worthwhile, regardless of their purpose? If not, then for which trip purpose is it justified to regard saved time as an economic benefit? And how much is it worth?

Taking this into consideration, the benefits of savings in TTC are not included. This means that the benefits measured are understated.

The benefits accrued from the road masterplan is the sum of those generated by implementing each project included in the plan. Figure 13.1.1 shows the benefits of the masterplan in time series, as a sum of those by the three project groups.

The benefits during the period of 1990-1996 are the fruits of the implementation of the Project Group 1, and are expressed as an accumulation of differences of VOC between the "without" case and the case in which the projects included are completed as scheduled through 1996.

The benefits during the period of 1997-2001 are the sum of those by the Project Groups 1 and 2. The benefits by the Project Group 1 during this period are the differences of VOC between the "without" case and the case in which no investment for roads are undertaken after 1996 ("1996-network" case). The benefits by the Project Group 2 are the differences of VOC between the "1996-network" case and the case in which the projects included are completed as scheduled through 2001.

The benefits during the period of 2002-2006 is the sum of those by the Project Groups 1, 2 and 3, and measured in the same way as described above.

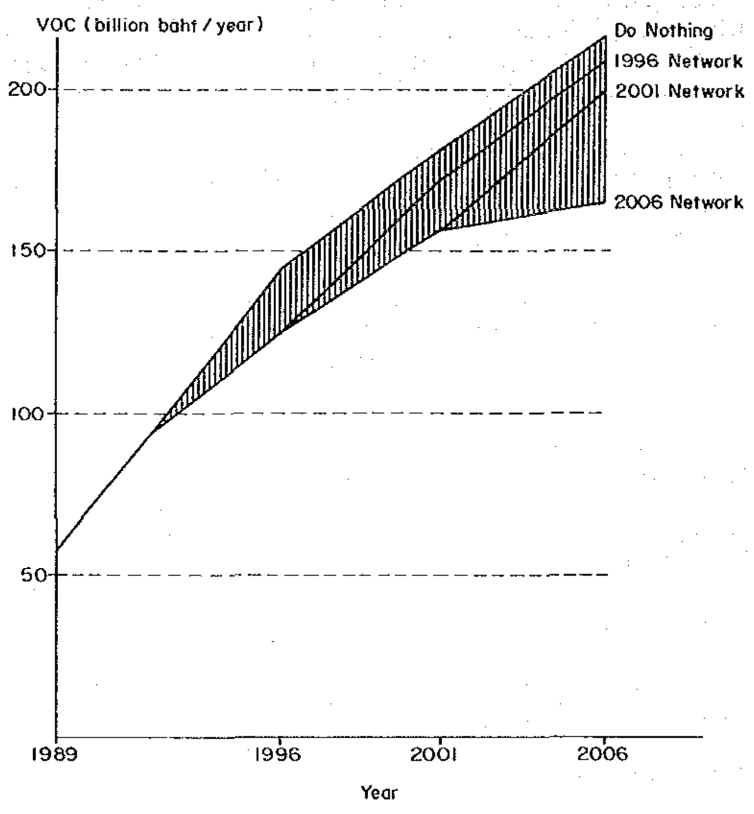


Figure 13.1.1 Benefit of Road Masterplan

3) Costs

The cost of the masterplan is the sum of investment and maintenance cost over the evaluation period. The annual investment costs are expressed in accounting prices (economic maintenance costs are obtained by aggregating those of each project completed. The amount of costs needed for maintenance and repairs of a road is assumed to be 2% of its total investment, without land costs, annually after the opening.

The life of a project is assumed to be 25 years. The residual value at the end of 2006 is calculated separately for the structure and land. The residual value of the structure is obtained by deducting the depreciated value during the period of the completion year and 2006 from the total investment without land costs. On the other hand, the residual value of land is assumed to be a possibility of use alteration. That is, the full value of the land used for a project will be regained when the project life will expire, and during the period of use a part of it will be recovered in proportion to the length of use period. Thus, the residual value of land is obtained as recovered value during the period of the completion year and 2006.

13.2 Vehicle Operating Cost and Travel Time Cost

Savings in vehicle operating cost (VOC) and travel time cost (TTC) constitute a large part of the total benefits in the cost-benefit analysis. They are defined as the differences in VOC and TTC between the two cases of "without" and "with" the project, and therefore VOC and TTC have to be determined for the various strategies and projects which are proposed by the Medium/Long-term Road Improvement *Plan*, ATC System and Common Utility Duct Study.

The cost-benefit analysis, mentioned above, is based on the perspective of national economy, and therefore the values of VOC and TTC are derived in terms of economic costs, which are prices and wages, etc. excluding taxes.

Based on data collection, hearings with concerned agencies and the review of related previous studies such as BTS, SSES, STTR and RDSC, the vehicle operating cost and travel time cost are estimated as described hereafter.

BTS - Bangkok Transportation Study (1975)
SSES - *Feasibility Study on the Second Stage Expressway* System in the Greater Bangkok (1983)
STTR - Short Term Urban Transport Review (1985)
RDSC - Road Development Study in the Central Region (1988)

1) Vehicle Operating Cost (VOC)

The procedure for estimation of VOC is shown in Figure 13.2.1.

(1) Representative Vehicles

Considering the current vehicle market and previous studies, representative vehicles by type and related data and assumptions are shown in Tables 13.2.1 and 13.2.2, respectively.

Table 13.2.1 Representative Vehicle

(Baht)

Type of Vehicle	Typical Vehicle	No. of Tires	Market Price	Economic Cost	Eco. Cost W/O Tires
M/C	Honda TG 125 Suzuki TRZ	2	34,900	25,200	24,900
P/C	Toyota Corona (1600 cc)	4	500,000	232,700	228,800
L/B	Toyota Hilux	4	265,300	205,200	200,600
M/B	Isuzu MPR59LU	6	532,600	451,100	434,600
H/B	Hino BY341	6	1,591,900	1,362,700	1,329,200
L/T	Toyota Hilux	4	259,000	199,500	194,900
M/T	Isuzu MPR59LU	6	519,500	439,300	422,800
H/T	Hino FM176	10	1,086,900	895,700	856,800
T/X	Toyota Corolla (1300 cc)	4	420,000	240,500	235,300
S/L	Daihatsu (250 cc)	3	45,000	36,500	35,400

(2) Components of VOC

Components of VOC are divided into the following 7 items:

a. Fuel
b. Oil
c. Tires
d. Maintenance (parts and labor)
e. Depreciation (use and age) and Interest
f. Wages
g. Overhead

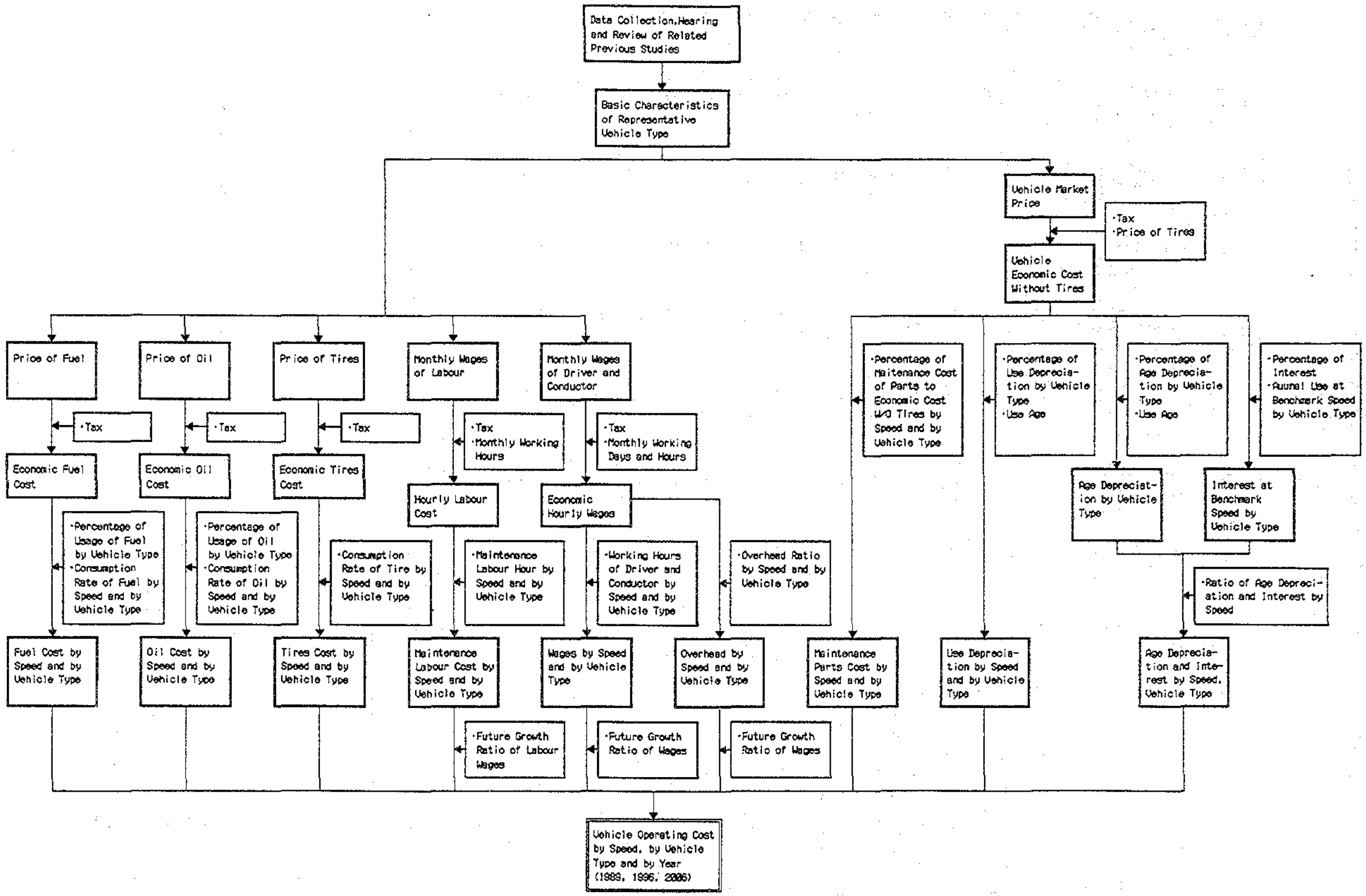


Figure 13.2.1 Flow Chart for Estimation of Vehicle Operating Cost

Table 13.2.2 Data Assumption on Vehicle Operation Cost

Items	A Motorcycle	B Car	C Minibus	D Medium Bus	E Heavy Bus	F Light Truck	G Medium Truck	H Heavy Truck	I Taxi
1. Representative vehicle	Honda TG 125	Corona 1600	Hilux	Isuzu MPR59LU	Hino BY341	Hilux	Isuzu MPR59LU	Hino FM176	Coroll 1300
2. Market price (Baht)	34900	500000	265300	532600	1591900	259000	519500	1086900	42000
3. Economic cost (Baht)	25200	232700	205200	451100	1362700	199500	439300	895700	24050
4. Economic cost without tires (Baht)	24900	228800	200600	434600	1329200	194900	422800	856800	23530
5. Percentage use depreciation	80	65	90	90	90	100	100	100	10
6. Use life (000 kms)	80	160	250	350	480	250	400	450	20
7. Use depreciation/000 kms	249	930	722	1118	2492	780	1057	1904	117
8. Benchmark journey speed (km/h)	30	30	18	20	20	29	27	25	2
9. Annual use at benchmark speed (000 kms)	10	12	50	60	80	40	50	60	8
10. Age depreciation/000 kms at benchmark speed (Baht)	62	501	80	124	277	-	-	-	
11. Annual economic interest (Baht)	1494	13728	12036	26076	79752	11694	25368	51408	1411
12. Interest/000 kms at benchmark speed (Baht)	149	1144	241	435	997	292	507	857	16
13. Life at benchmark speed (years)	8.0	13.3	5.0	5.8	6.0	6.3	8.0	7.5	2.
14. Monthly wages, financial (Baht)	-	-	2460	5070	8700	2460	3970	5400	625
15. Daily wages, financial (Baht)	-	-	98	203	348	98	159	216	25
16. Daily wages, economic (Baht)	-	-	89	183	313	89	143	194	22
17. Average working hours of vehicle/day	-	-	10	12	14	10	11	12	1
18. Benchmark running hours/day	-	-	8	10	12	5	7	8	1
19. Benchmark standing hours/day	-	-	2	2	2	5	4	4	
20. Running distance (kms)/day	-	-	144	200	240	145	189	200	30
21. Days per year worked	-	-	347	300	333	276	265	300	29
22. Economic cost of wages/000 kms at benchmark Speed (Baht)	-	-	615	913	1305	611	756	972	75

Note 1 : A - H -> "Road Development Study in the Central Region (JICA March, 1989)", Page 6-2.
I and J -> "STTR Internal Working Paper No. 6 Travel Cost", Page 21.
2 : A, B, F, G, I, J -> Obtained latest market price (July, 1989) from hearings with dealers. Other vehicles are a latest price and on the basis of previous study.
3 and 4 : Estimated from the percentage of 3 and 4 to 2 , based on STTR and RDSC data.
5 and 6 : Based on STTR data.
7 = 4 x (5 /100) ÷ 6
8 and 9 : Based on STTR data.
10 = 4 x (1 - 5 /100) ÷ 6
11 = 4 x 0.12 ÷ 2
12 = 11 ÷ 9
13 = 6 ÷ 9
14 : C - H -> From 1988 RDSC JICA Study data, assumed to have risen in line with the increase rate of minimum wage i (3.0%).
15 = 14 ÷ 25 Days
16 : 90% of 15 . Based on STTR data.
17 , 18 and 19 : Based on STTR data.
20 = 8 x 18
21 = 9 x 1000 ÷ 20
22 = 16 x 21 ÷ 9 = 16 x 1000 ÷ 20

(3) Examination of Each VOC Component

a. Fuel Cost

Table 13.2.3 shows the details for cost of fuel by type obtained from information provided by the National Energy Policy Office.

Table 13.2.3 Details for Cost of Fuel by Type

(Baht/liter)

Type of Fuel	ECONOMIC COST				TAXES			FINANCIAL COST
	Ex-refinery Price	Import Price	Marketing Margin	Total	Import Duty	Excise & Mpal Taxes	Oil Fund	Retail Price
GASOLINE SUPER								
Locally Refined	4.3461		0.6220	4.9681		4.2420	-0.7601	8.45
Imported		4.2785	0.6220	4.9005	0.0100	4.2420	-0.7025	8.45
GASOLINE REGULAR								
Locally Refined	3.8400		0.5809	4.4209		4.2420	-0.9129	7.75
Imported		3.7387	0.5809	4.3196	0.0100	4.2420	-0.8216	7.75
HP.DIESEL								
Locally Refined	3.7837		0.4858	4.2695		2.6765	-0.8460	6.10
Imported		3.5009	0.4858	3.9867	0.0100	2.6765	-0.5732	6.10
LPG (Baht/kg)								
Locally Refined	5.2653		1.0628	6.3281		2.5000	1.0219	9.85
Imported		3.8105	1.0628	4.8733	0.0010	2.5000	2.4757	9.85

Source: National Energy Policy Office

Note : Specific Gravity of LPG is 0.540 kg/lit.

Considering the utilization proportion of imported and locally refined fuel, the average economic cost of fuel by type is shown in Table 13.2.4.

Table 13.2.4 Average Economic Cost of Fuel by Type

(Baht/liter)

Type of Fuel	Supply Compos'n	Financial Cost	Economic Cost
GASOLINE SUPER			
Locally Refined	80%	8.45	4.97
Imported	20%	8.45	4.90
Average Price		8.45	4.96
GASOLINE REGULAR			
Locally Refined	80%	7.75	4.42
Imported	20%	7.75	4.32
Average Price		7.75	4.40
HP.DIESEL			
Locally Refined	42%	6.10	4.27
Imported	58%	6.10	3.99
Average Price		6.10	4.11
LPG			
Locally Refined	76%	5.40	3.47
Imported	24%	5.40	2.67
Average Price		5.40	3.28

Fuel cost per km by type of vehicle is shown in Table 13.2.5, based on Table 13.2.4 and the fuel consumption rate per 1000 km by type of vehicle.

b. Oil Cost

The procedure for estimation of oil cost is basically the same as that for fuel cost. The basic information, such as latest price of oil, was made available at hearings with manufacturers and agencies.

Considering the taxes and consumption rate of oil by type of vehicle, the oil cost per km by type of vehicle is shown in Table 13.2.5.

c. Tires Cost

The procedure for estimation of tires cost is basically the same as that for fuel cost and oil cost.

The result is also shown in Table 13.2.5.

Table 13.2.5 Fuel Cost, Oil Cost and Tires Cost by Type of Vehicle

Items	A Motor-cycle	B P.Car	C Light Bus	D Medium Bus	E Heavy Bus	F Light Truck	G Medium Truck	H Heavy Truck	I Taxi	J Samlor
FUEL										
Kind of Fuel										
Gasoline Super		65	10			10				
Gasoline Regular	100	25	10			10				
HP.Diesel		10	80	100	100	80	100	100		
LPG									100	100
Economic Cost (Baht/liter)	4.4	4.74	4.22	4.11	4.11	4.22	4.11	4.11	3.28	3.28
Benchmark Speed (km/hr)	30	30	18	20	20	29	27	25	25	24
Consumption (liter/1000 km)	32	108.1	162.8	197	311.2	125.6	171.4	327.4	111.1	52.6
Fuel Cost (Baht/km)	0.141	0.512	0.687	0.81	1.279	0.53	0.704	1.346	0.364	0.173
OIL										
Economic Cost (Baht/liter)	37.6	37.2	34.4	33.6	33.6	34.4	33.6	33.6	37.6	37.6
Consumption (liter/1000 km)	0.1	0.5	0.7	1.4	2	0.7	1.4	2	0.5	0.3
Oil Cost (Baht/km)	0.004	0.019	0.024	0.047	0.067	0.024	0.047	0.067	0.019	0.011
TIRE										
Economic Cost (Baht/tire)	153	775	928	2281	4730	928	2281	3405	775	365
Average Speed (km/hr)	55	70	60	60	60	60	60	60	70	60
Consumption (tire/1000 km)	0.061	0.089	0.089	0.133	0.12	0.089	0.133	0.182	0.089	0.075
Conversion Ratio (BS/AS)	0.679	0.535	0.546	0.556	0.556	0.617	0.598	0.579	0.495	0.57
Tire Cost (Baht/km)	0.006	0.037	0.045	0.169	0.316	0.051	0.181	0.359	0.034	0.016

d. Maintenance (Parts and Labor)

The estimation of maintenance cost is basically divided into parts and labor.

The maintenance cost of parts is considered to be a correlation between the percentage of that cost and the vehicle economic cost.

The percentages of maintenance cost of parts to vehicle economic cost by vehicle type used in this study, are based on STTR data.

On the other hand, the basic consideration for maintenance cost of labor is labor working hours per unit running kilometer of vehicle. The labor working hours per unit running kilometer are based on SSES data, and hourly labor cost is as follows:

1986 ~ 1989 (exponent 3)

$$3{,}861 \text{ B/m} \times (1.03)^{3} \times (4{,}690/3{,}861) \;/\; 198 \text{ H/M} = 26 \text{ B/hr}$$

3,861 B/m	(1.03)	(4,690/3,861)	198 H/M
Average monthly wage in 1986	Average Annual Increase ratio of minimum wage (1981-1987)	Wage Difference between Bangkok and whole country	Average monthly working hours

Assuming that the future increase of hourly labor cost is in proportion to the future increase of GDP per employed person, the hourly labor costs in 1996 and 2006 are as follows:

GDP per employed person	Year 1989	--->	66,801 Baht
	1996	--->	99,505
	2006	--->	138,476
Future increase rate	1996/1989	--->	1.490
	2006/1989	--->	2.073
Hourly labor cost by year	Year 1989	--->	26 Baht/hour
	1996	--->	39
	2006	--->	54

Maintenance cost of parts and labor by vehicle type and by year, obtained from the above estimation procedure, are summarized in Table 13.2.6.

Table 13.2.6 Maintenance Cost (Parts and Labor) for 20 km/h of Vehicle Speed

1989 (Baht/1000 Km)

Type of Vehicle	Parts	Labor	Total
M/C	12	11	24
P/C	137	29	166
L/B	80	35	115
M/B	391	98	489
H/B	798	156	954
L/T	117	35	152
M/T	381	98	478
H/T	600	156	756
T/X	141	26	167
S/L	11	10	21

1996 (Baht/1000 Km)

Type of Vehicle	Parts	Labor	Total
M/C	12	17	30
P/C	137	43	180
L/B	80	53	133
M/B	391	147	538
H/B	798	234	1032
L/T	117	53	170
M/T	381	147	527
H/T	600	234	834
T/X	141	39	180
S/L	11	16	26

2006 (Baht/1000 Km)

Type of Vehicle	Parts	Labor	Total
M/C	12	24	36
P/C	137	59	197
L/B	80	73	153
M/B	391	203	594
H/B	798	324	1122
L/T	117	73	190
M/T	381	203	584
H/T	600	324	924
T/X	141	54	195
S/L	11	22	32

e. Depreciation (Use and Time) and Interest

Usually, depreciation is divided into use and age, and each is estimated individually.

Table 13.2.7 shows the proportion between use depreciation and age depreciation, according to STTR.

Table 13.2.7 The Proportion between Use and Age Depreciation by Vehicle Type

(%)

Items	M/C	P/C	L/B	M/B	H/B	L/T	M/T	H/T	T/X	S/L
Use Dep.	80	65	90	90	90	100	100	100	100	100
Age Dep.	20	35	10	10	10	0	0	0	0	0

Use and age depreciation are estimated from the above proportions, as well as vehicle economic cost by type and life of vehicle.

On the other hand, interest (interest/1000 kms at benchmark speed) is obtained from annual economic interest which is determined according to the following formula and annual use at benchmark speed.

Annual Economic Interest = Vehicle Economic Cost
x Annual Interest (12.0)/2

f. Wages

Cost of wages for drivers, conductors and assistants is obtained from monthly wages of these staff and the no. of personnel by vehicle type.

The monthly wages for personnel of buses and trucks shown in the 1988 data of the RDSC JICA Study, are assumed to have risen in line with the increase ratio of minimum wage in Bangkok; while, wages for drivers of taxi and samlor have been taken from the results of the para-transit drivers' survey.

Considering the monthly wages of personnel and monthly working hours, the economic cost of wages by vehicle type have been calculated.

Table 13.2.8 Average Monthly Wage of Personnel by Vehicle Type

Items	L/B	M/B	H/B	L/T	M/T	H/T	T/X	S/L
1988 Wage	2,390	4,920	8,450	2,390	3,850	5,240	-	-
Index	1.03	1.03	1.03	1.03	1.03	1.03		
1989 Wage	2,460	5,070	8,700	2,460	3,970	5,400	6,250	3,840
Monthly Working days	25	25	25	25	25	25	25	25
Tax	10%	10%	10%	10%	10%	10%	10%	10%
Wage Without Tax	89	183	313	89	143	194	225	138

g. Overhead

Assuming that the overhead cost is in proportion to the cost of wages, the overhead cost has been estimated according to the following 5 vehicle types.

i) Light Bus
ii) Medium Bus
iii) Heavy Bus
iv) Medium Truck
v) Heavy Truck

The percentage of overhead cost to cost of wages is based on the STTR data.

(4) Vehicle Operating Cost by Vehicle Type, by Speed and by Year

Based on the above estimation, the vehicle operating costs by vehicle type, by speed and by year are shown in Table 13.2.9 and Figure 13.2.2.

The ratio of vehicle operating cost by speed is based on STTR data. The basic considerations for vehicle operating cost by year are as follows:

1. It is assumed that costs related to wages, such as labor maintenance cost, cost of wages and overhead cost, increase in proportion to the future growth rate of GDP per employed person.

2. Other costs are constant at 1989 prices.

Table 13.2.9 Vehicle Operating Cost by Vehicle Type, by Speed and by Year

1989 (Baht/1000 Km)

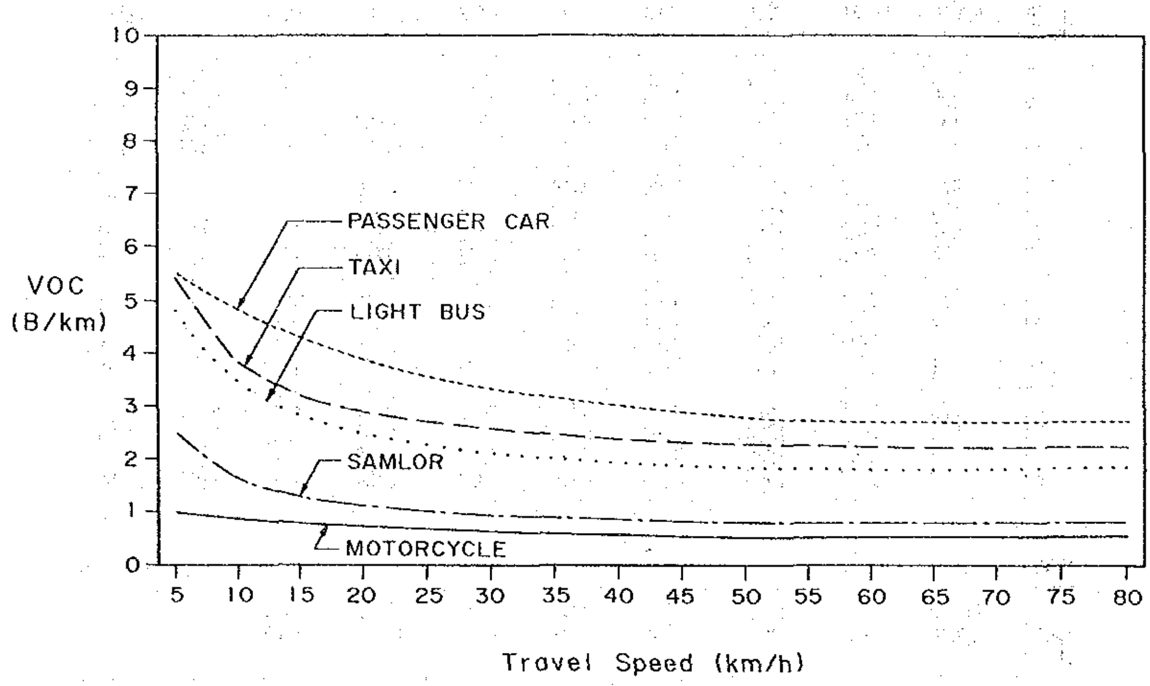
Speed (km/h)	Motor-cycle	P.Car	Light Bus	Medium Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck	Taxi	Samlor
5	995	5504	4744	8936	15968	4967	7529	9567	5396	2475
10	899	4838	3404	6159	11957	3591	5656	7259	3817	1586
15	795	4266	2796	5038	10055	2987	4867	6223	3189	1271
20	726	3866	2471	4429	9044	2671	4428	5634	2876	1104
25	675	3562	2258	3995	8416	2467	4167	5289	2680	998
30	635	3326	2117	3733	7963	2328	3970	501	2548	927
35	607	3143	2015	3544	7628	2235	3851	4850	2455	878
40	583	2988	1945	3394	7351	2168	3759	4718	2376	843
45	565	2861	1893	3284	7118	2115	3715	4653	2320	816
50	552	2766	1848	3221	6914	2083	3668	4588	2285	796
55	539	2686	1826	3188	6833	2054	3639	4549	2260	785
60	531	2686	1807	3159	6767	2033	3621	4529	2239	782
65	536	2689	1812	3169	6712	2017	3622	4540	2224	786
70	533	2692	1820	3192	6738	2007	3631	4561	2210	794
75	534	2704	1835	3222	6752	2007	3663	4619	2205	805
80	539	2720	1868	3289	6806	2013	3734	4740	2206	821

1996 (Baht/1000 Km)

Speed (km/h)	Motor-cycle	P.Car	Light Bus	Medium Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck	Taxi	Samlor
5	1001	5517	5700	10796	18888	5956	8969	13417	6747	3350
10	905	4852	3960	7225	13921	4160	6581	10174	4564	2073
15	801	4280	3210	5830	11631	3417	5614	8797	3730	1629
20	731	3881	2817	5083	10425	3034	5083	8026	3315	1399
25	680	3577	2560	4546	9684	2790	4766	7565	3061	1254
30	640	3341	2391	4229	9146	2624	4531	7213	2888	1157
35	613	3159	2269	3999	8731	2511	4384	7000	2765	1090
40	590	3003	2183	3819	8393	2431	4272	6835	2665	1042
45	571	2877	2120	3686	8105	2366	4214	6755	2592	1004
50	559	2782	2065	3606	7858	2326	4156	6672	2545	976
55	547	2703	2033	3559	7737	2290	4117	6620	2510	959
60	538	2705	2009	3518	7637	2264	4092	6590	2480	951
65	544	2708	2009	3519	7554	2243	4087	6594	2458	950
70	541	2713	2014	3535	7555	2230	4091	6610	2437	954
75	542	2725	2025	3559	7547	2226	4118	6669	2427	961
80	547	2741	2055	3623	7584	2230	4187	6798	2424	974

2006 (Baht/1000 Km)

Speed (km/h)	Motor-cycle	P.Car	Light Bus	Medium Bus	Heavy Bus	Light Truck	Medium Truck	Heavy Truck	Taxi	Samlor
5	1007	5534	6837	13008	22363	7133	10683	15608	8355	4391
10	911	4869	4621	8493	16259	4837	7681	11612	5453	2653
15	807	4297	3703	6773	13505	3928	6503	9973	4374	2055
20	737	3898	3228	5861	12067	3466	5863	9067	3839	1750
25	686	3594	2919	5201	11193	3173	5478	8523	3513	1558
30	647	3359	2717	4820	10553	2977	5199	8114	3291	1432
35	620	3177	2571	4541	10044	2839	5019	7858	3135	1342
40	597	3021	2467	4325	9633	2744	4882	7663	3008	1279
45	579	2896	2389	4165	9279	2664	4808	7564	2915	1228
50	568	2802	2322	4065	8980	2615	4737	7465	2854	1190
55	555	2724	2281	4000	8813	2571	4686	7398	2806	1166
60	547	2727	2249	3944	8673	2538	3652	7358	2767	1151
65	554	2732	2244	3935	8556	2512	4640	7353	2736	1146
70	551	2737	2245	3943	8527	2495	4637	7362	2707	1145
75	552	2749	2252	3960	8494	2487	4660	7415	2691	1147
80	557	2766	2277	4020	8509	2488	4726	7541	2683	1156



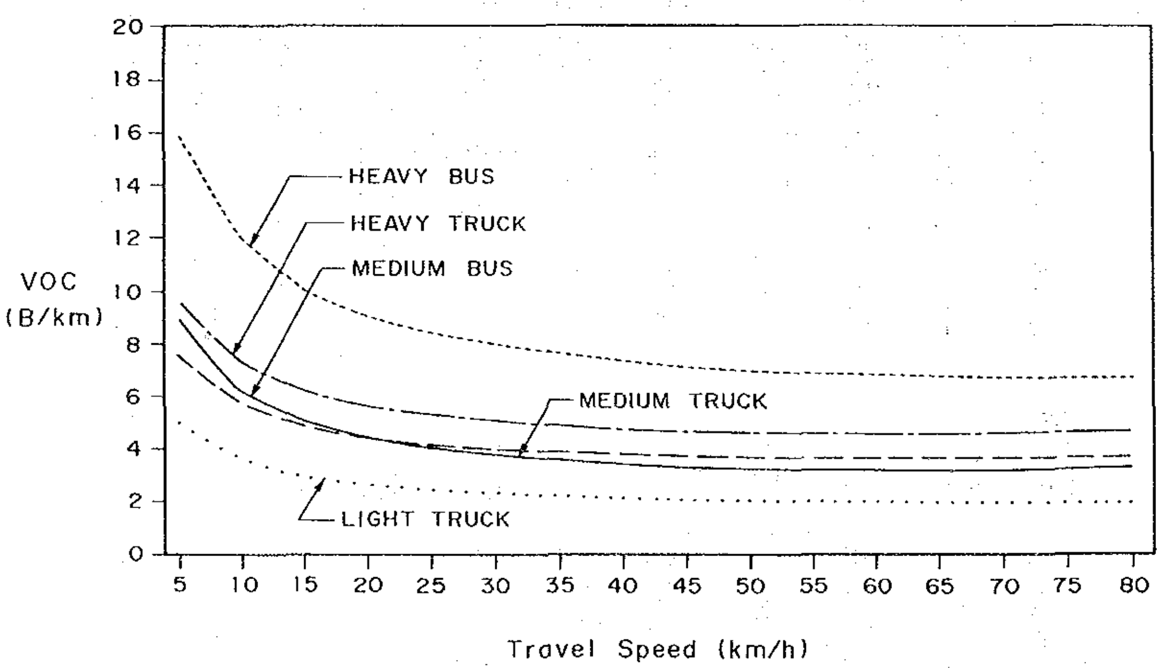


Figure 13.2.2 Vehicle Operating Cost by Vehicle Type and by Speed in 1989

(5) Rail Transit Operating Cost

The rail transit operating costs are composed of fixed costs and variable costs. The former is proportionate to the route lengths operated and the latter to the passengers transported.

The fixed and variable costs include the following items, respectively:

a. Fixed Costs

1. Initial Expatriate Management Service
2. Personnel Cost for General Management
3. Maintenance Cost for Track and Structure
   3-1 Building and Machinery
   3-2 Guideway
   3-3 Signal and Communication
   3-4 Stations

b. Variable Costs

1. Personnel Cost for Administration
2. Personnel Cost for Operation
3. Power Cost
4. Workshop/Car House
5. Depreciation and Interest of Car

Applying 1989 prices to the cost data given in the "Bangkok Transit System Study, Volume 5" (Lavalin International, 1986), an equation is obtained as shown below:

$$C = 85.04\ P + 3.98\ L + 68.00 \qquad (\text{If } L = 0,\ C = 0)$$

where;

C : Annual Operating Cost (million Baht/year)
P : Daily Passengers Transported (million person-kilometers/day)
L : Route Lengths Operated (Km)

The future annual operating cost of the rail transit is forecast by substituting the calculated daily passengers transported and the route length operated in the target years for P and L in the equation, respectively.

2) Travel Time Cost (TTC)

GDP (Gross Domestic Product) is the basis for determining travel time cost because this cost will be used in the cost-benefit analysis from the perspective of regional economy. The time value of passengers, which is the basic figure of TTC, is analyzed according to two categories, which are business related trips and trips for other purposes.

The procedure for analysis of TTC is shown in Figure 13.2.3.

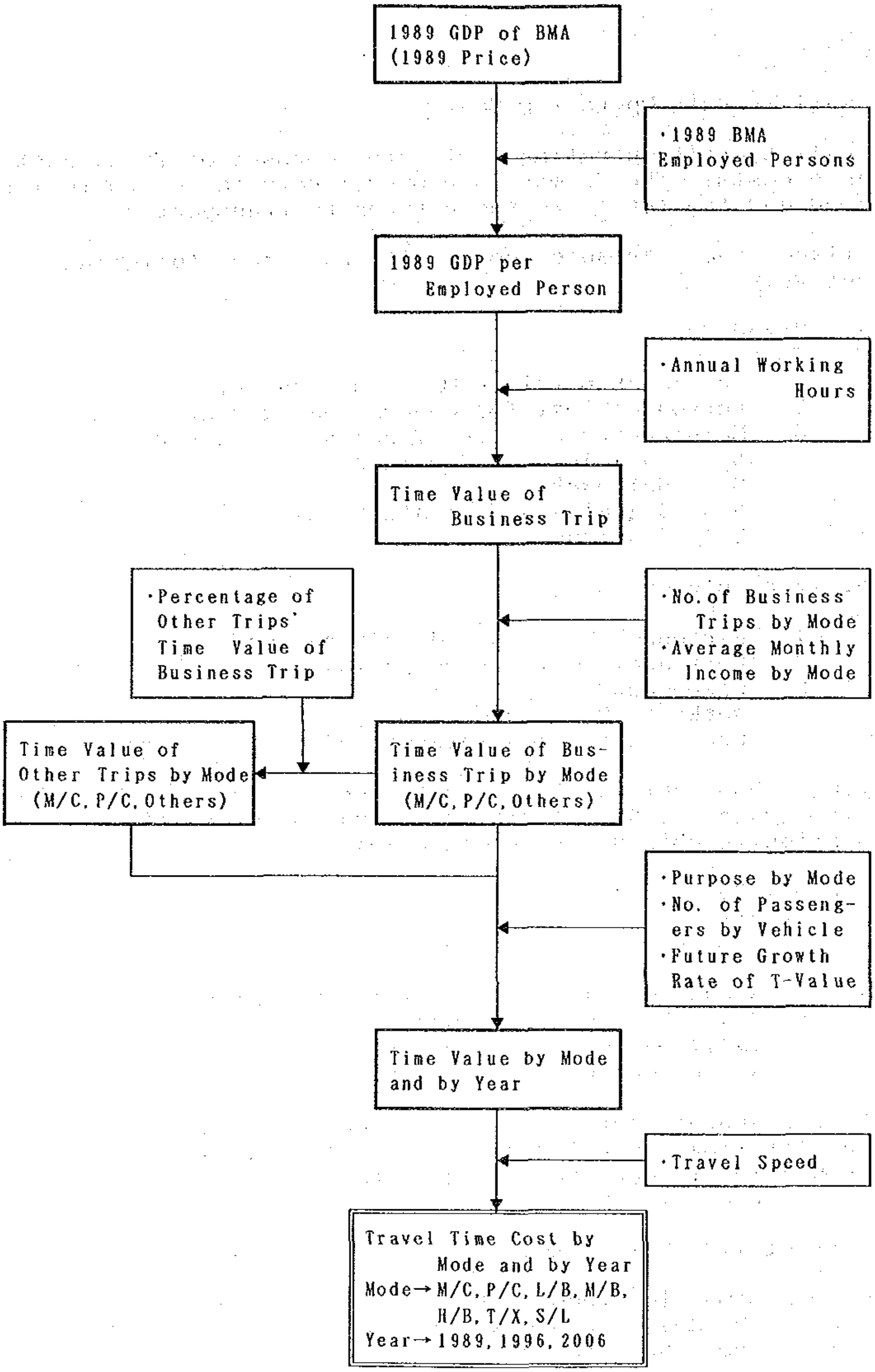


Figure 13.2.3 Procedure for analysis of TTC

(1) Time Value of Passengers for Business Purpose

The time value of passengers for business purpose is based on the GDP per employed person in BMA.

a. GDP per employed person

GDP per employed person in BMA is described as follows, based on 1989 GDP in Bangkok and the no. of employed persons.

Table 13.2.10 1989 GDP Per Employed Person in BMA

Items	Formula/Figures
1. GDP in Thailand in 1987	1,223,218 mill.B. (1987 Current Price) 441,894 mill.B. (1972 Constant Price) Current Price/Constant Price =2.768
2. GDP in BMA (1987 current price)	178,061.8 x 2.768 = 492,875 mill.B. (1972 Constant Price)
3. Average annual growth rate of GDP in current price between 1983 and 1987	1987/1983 = 1,223,218 mill.B. / 910,054 mill.B. = 1.344 $(1.344)^{1/4}$ = 1.0767 -> 7.67 %
4. 1989 GDP in BMA (1989 price)	492,875 x $(1.0767)^2$ = 571,382 mill.B.
5. Number of employed person in BMA in 1989	2,376,199 person (From SIMR Study)
6. GDP per employed person in 1989	571,382 / 2.376199 = 240,461 Baht/employed person

b. Time value of business trip

A shown in Table 13.2.10, the current GDP per employed person in the Metropolitan Region is estimated at 240,000 Baht. Dividing this by average monthly working hours (216 hours) the time value of a business trip is evaluated to be 93 Baht per hour.

240,000 ÷ (216 x 12) ÷ 93 Baht/hour

c. Time value of business trip by mode

For the purpose of this study, the time value of business trips is expressed by the following modes:

M/C	----->	Motorcycle
P/C Group	----->	Passenger Car, Taxi and Samlor
Others	----->	Bus

Proportion of no. of business trips by mode is as follows, based on the Person Trip Survey:

P/C		M/C		Others		Total
1,107,820	+	259,941	+	250,737	=	1,618,498
(68.4 %)		(16.1 %)		(15.5 %)		

Representative average monthly income of business trip maker by mode is assumed to be as follows based on the monthly income by occupation obtained from PT Survey.

Figure 13.2.4 Personal Income by Occupation

Items	A Prof.	B Admi.	C ShopOwner	D Cleri.	E Sales	F Agri.	G Miners	H Trans.	I Labours	J Service	K Total
Income	6015	9629	5864	5230	3705	2694	3112	4201	3690	3386	5627
Person	219930	582289	433539	195467	218423	37759	1798	96380	613791	257756	2657132

Mode	P/C	Others	M/C
Income	8638	3856	5627
Remarks	A+B	E-J	Total Ave.

Assuming that the time value of business trip by mode is in proportion to the personal income by mode, time value of business trip by mode is as follows:

A x 0.684 + B x 0.161 + C x 0.155 = 93 Baht/Hour
A : B : C = 8638 : 5627 : 3856

Therefore, A : Time value of business trip by P/C Group = 108 Baht/Hour
B : Time value of business trip by M/C = 71
C : Time value of business trip by bus = 48

(2) Time Value of Passengers for Other Purposes

a. Determining the time value of other purpose trip makers

Based on the review of related previous studies, determining the time value of other trips is as follows:

To/from work and private -----> 25% of business trip
To/from school -----> 0% of business trip

b. Time value of other trips, by vehicle

Considering the no. of trips by vehicle, the percentage of time value of other trips to business trips by vehicle is as follows:

(Excluding to/from school)		(To/from school)	
To Work ----->	2,468,588	To School ----->	1,308,713
Private ----->	1,903,692	From School ----->	1,308,713
Go Home ----->	5,244,167		
	- 1,308,713		
	8,307,734		2,617,426

The percentage of time value for other trip makers to business trip makers is as follows based on these figures:

(8,307,734 x 25% + 2,617,426 x 0%)/(8,307,734+2,617,426)=19%

No. of trips excluding school — No. of to/from school trips

c. Time value of other trips by mode

From the above mentioned formula, time value of other trips is shown below.

Time value of other trips by P/C group =108 x19% = 21 Bht/hr
Time value of other trips by M/C = 71 x19% = 13
Time value of other trips by Bus = 48 x19% = 9

(3) Time Value by Mode and by Year

Considering the above results and the future growth ratio of time value (1996/1989 = 1.490, 2006/1989 = 2.073 -> based on GDP growth ratio), the average no. of passengers by mode and the proportion of business trips to other trips, the time value by mode and by year are shown in Table 13.2.11.

Table 13.2.11 Time Value by Mode and by Year

1989 (Baht/hour)

Type of Vehicle	Business Trip	Other Trip	Total
M/C	11.2	16.1	27.4
P/C	44.3	29.2	73.5
L/B	8.4	43.4	51.8
M/B	18.5	95.5	114.0
H/B	63.6	213.1	276.7
T/X	19.4	21.4	40.9
S/L	19.4	21.4	40.9

1996 (Baht/Hour)

Type of Vehicle	Business Trip	Other Trip	Total
M/C	16.7	24.1	40.8
P/C	66.0	43.5	109.5
L/B	12.5	64.7	77.2
M/B	27.5	142.3	169.9
H/B	94.8	317.5	412.2
T/X	29.0	31.9	60.9
S/L	29.0	31.9	60.9

2006 (Baht/Hour)

Type of Vehicle	Business Trip	Other Trip	Total
M/C	23.3	33.5	56.7
P/C	91.9	60.5	152.4
L/B	17.4	90.0	107.4
M/B	38.3	198.0	236.4
H/B	131.8	441.7	573.5
T/X	40.3	44.4	84.7
S/L	40.3	44.4	84.7

(4) Travel Time Cost by Mode, Speed, and Year

Considering time value and travel speed by mode, travel time cost by mode, speed and year is shown in Table 13.2.12 and Figure 13.2.5.

Table 13.2.12 Travel Time Cost by Mode, Speed, and Year

1989 (Baht/1000 Km)

Speed (km/h)	Motor-cycle	P.Car	Light Bus	Medium Bus	Heavy Bus	Taxi	Samlor
5	5480	14700	10360	22800	55340	8180	8180
10	2740	7350	5180	11400	27670	4090	4090
15	1827	4900	3453	7600	18447	2727	2727
20	1370	3675	2590	5700	13835	2045	2045
25	1096	2940	2072	4560	11068	1636	1636
30	913	2450	1727	3800	9223	1363	1363
35	783	2100	1480	3257	7906	1169	1169
40	685	1838	1295	2850	6918	1023	1023
45	609	1633	1151	2533	6149	909	909
50	548	1470	1036	2280	5534	818	818
55	498	1336	942	2073	5031	744	744
60	457	1225	863	1900	4612	682	682
65	422	1131	797	1754	4257	629	629
70	391	1050	740	1629	3953	584	584
75	365	980	691	1520	3689	545	545
80	343	919	648	1425	3459	511	511

1996 (Baht/1000 Km)

Speed (km/h)	Motor-cycle	P.Car	Light Bus	Medium Bus	Heavy Bus	Taxi	Samlor
5	8160	21900	15440	33980	82440	12180	12180
10	4080	10950	7720	16990	41220	6090	6090
15	2720	7300	5147	11327	27480	4060	4060
20	2040	5475	3860	8495	20610	3045	3045
25	1632	4380	3088	6796	16488	2436	2436
30	1360	3650	2573	5663	13740	2030	2030
35	1166	3129	2206	4854	11777	1740	1740
40	1020	2738	1930	4248	10305	1523	1523
45	907	2433	1716	3776	9160	1353	1353
50	816	2190	1544	3398	8244	1218	1218
55	742	1991	1404	3089	7495	1107	1107
60	680	1825	1287	2832	6870	1015	1015
65	628	1685	1188	2614	6342	937	937
70	583	1564	1103	2427	5889	870	870
75	544	1460	1029	2265	5496	812	812
80	510	1369	965	2124	5153	761	761

Table 13.2.12 Travel Time Cost by Mode, Speed, and Year (Cont'd)

2006 (Baht/1000 Km)

Speed (km/h)	Motor-cycle	P.Car	Light Bus	Medium Bus	Heavy Bus	Taxi	Samlor
5	11340	30480	21480	47280	114700	16940	16940
10	5670	15240	10740	23640	57350	8470	8470
15	3780	10160	7160	15760	38233	5647	5647
20	2835	7620	5370	11820	28675	4235	4235
25	2268	6096	4296	9456	22940	3388	3388
30	1890	5080	3580	7880	19117	2823	2823
35	1620	4354	3069	6754	16386	2420	2420
40	1418	3810	2685	5910	14338	2118	2118
45	1260	3387	2387	5253	12744	1882	1882
50	1134	3048	2148	4728	11470	1694	1694
55	1031	2771	1953	4298	10427	1540	1540
60	945	2540	1790	3940	9558	1412	1412
65	872	2345	1652	3637	8823	1303	1303
70	810	2177	1534	3377	8193	1210	1210
75	756	2032	1432	3152	7647	1129	1129
80	709	1905	1343	2955	7169	1059	1059

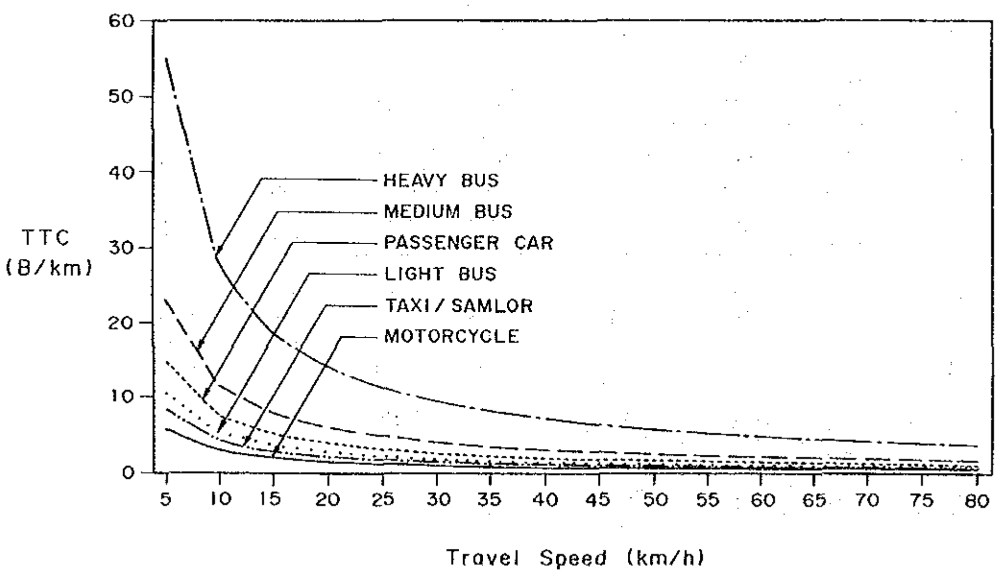


Figure 13.2.5 Travel Time Cost by Mode and by Speed in 1989

13.3 Evaluation Results

1) Road Masterplan as a Whole

The flow of cost and benefit during the period between 1990 and 2006 is shown in Figure 13.3.1.

As shown in Table 13.3.1, the net benefit will shift to a positive balance at the end of the 7th Plan period, and will maintain positive values thereafter at a level of 10 billion Baht per year during the 8th Plan period. After 2002, it will widen rapidly to a level of 30 billion Baht per year in 2006 excluding residual values.

As the evaluation indicators show, the masterplan as a whole is considered to be economically feasible.

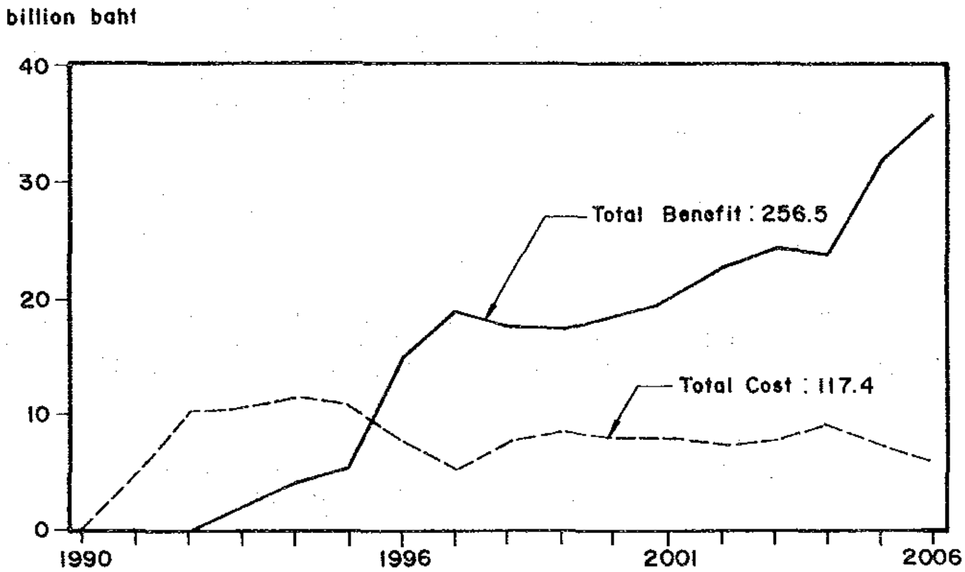


Figure 13.3.1 Flow of Cost and Benefit
-Road Masterplan-

Table 13.3.1 Economic Analysis of Road Masterplan

(million Baht, %)

Year	Invest-ment Cost	Mainte-nance Cost	Annual Total Cost	Annual Benefit	Annual Net Benefit
1990	249	0	249	0	-249
1991	4813	0	4813	0	-4813
1992	10277	0	10277	0	-10277
1993	10499	96	10595	2147	-8448
1994	11410	186	11596	4160	-7436
1995	10744	242	10986	5413	-5573
1996	7181	667	7848	14918	7070
1997	4425	847	5272	18944	13672
1998	6628	870	7498	17565	10067
1999	7624	940	8564	17222	8658
2000	6863	1074	7937	18287	10350
2001	6762	1227	7989	19770	11781
2002	5873	1442	7315	22619	15304
2003	6373	1491	7864	24320	16456
2004	7716	1497	9213	23707	14494
2005	5676	1664	7340	31760	24420
2006	4255	1754	-74335	35668	110003
Total	117368	13997	51021	256500	205479
Res. Val	80344				
NPV	26878				
B/C	1.65				
IRR	21.97				

This evaluation is based on the assumption that the rail transit projects will be completed as scheduled by the study team. Table 13.3.2 shows the benefits of the road masterplan in both cases of with and without the rail transit projects.

Table 13.3.2 Benefits of Road Masterplan with and without Rail Transit Project

(million Baht)

Year	With Rail Transit	Without Rail Transit
1996	14918	15323
2001	19770	19875
2006	35668	97497

There are no significant differences between the two cases. It could be said that the effects of the road masterplan are hardly influenced by the rail transit projects.

A sensitivity analysis is carried on the investment costs.

Table 13.3.3 Results of Sensitivity Analysis

	Base Case	Cost 10% up
NPV (million Baht)	26878	22772
B/C	1.65	1.50
IRR (%)	22.0	19.8

If the estimated investment costs rise by 10%, the IRR shall consequently fall by 2.2 percentage points. The level of the IRR at the base case is sufficiently high as to sustain such a fall, and the economic viability of the masterplan is considered to be stable in relation to the investment costs.

In this evaluation, the benefits are measured only for savings in VOC. However the savings in TTC, in spite of the difficulty in measuring them, are considered to be much larger than those in VOC. For reference, an analysis result, which includes the savings in TTC in the plan benefits, is shown in Table 13.3.4.

Table 13.3.4 Comparison of Base Case and Case including TTC

(million Baht, %)

	Base Case	Including TTC
Benefit		
1996	14918	89836
2001	19770	133648
2006	35668	237193
NPV	26878	400670
B/C	1.65	10.8
IRR	22.0	96.7

If savings in TTC are included in the benefit calculation, the annual benefit shall multiply by 6-7 times. As a result, the evaluation indicators become extremely attractive.

This fact suggests that a project showing slightly lower evaluation indicators based only on VOC is not necessarily unfeasible. Anyway, the road masterplan proposed in the study is feasible regardless of the savings in TTC.

2) Evaluation by Type of Project

Figures 13.3.2 to 13.3.4 show the flows of cost and benefit of the expressway, the at-grade main road, and the bus-way projects, respectively.

The patterns of the benefit curve of the expressway and the at-grade main road projects are similar in that at the end of the 7th Plan period the benefits reach a considerable level, during the 8th Plan period the curves follow a gentle upward path, which shifts to a steep upward course during the 9th Plan period.

On the other hand, the benefit curve of the bus-way projects maintains an almost constant rising trend. This suggests that the effects of bus-way projects are felt when a considerable number of the projects are put in service together.

The evaluation indicators of each type of project are shown in Table 13.3.5.

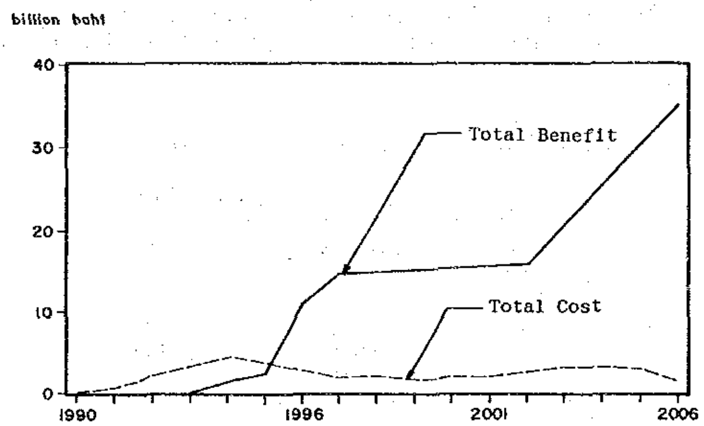


Figure 13.3.2 Flow of Cost and Benefit
- At-grade Main Road -

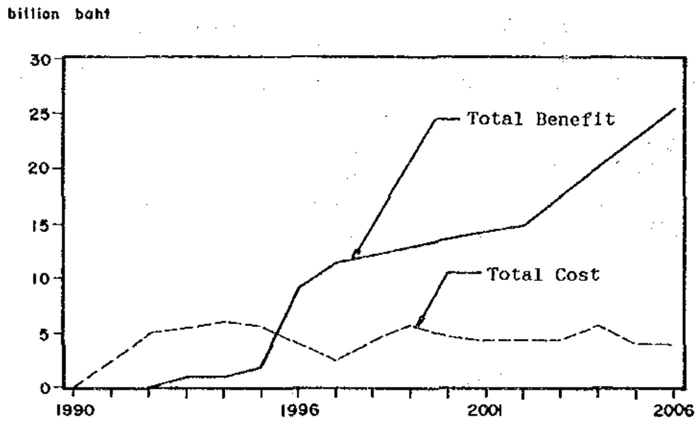


Figure 13.3.3 Flow of Cost and Benefit
- Expressway -

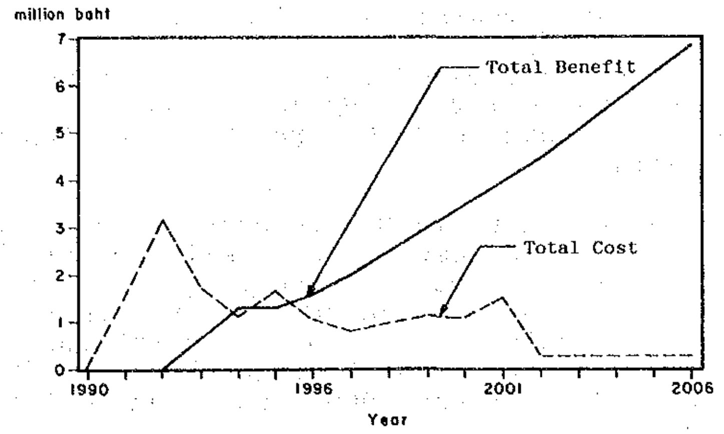


Figure 13.3.4 Flow of Cost and Benefit
- Bus-way -

Table 13.3.5 Evaluation Indicators by Type of Project

	Expressway	At-grade Main Road	Bus-way
NPV (million Baht)	23371	41523	4883
B/C	2.1	4.4	1.7
IRR (%)	26.3	48.4	20.5

According to the table, all three project types are considered to be economically feasible.

The indicators of the at-grade main road projects are outstandingly high.

As shown in Figure 13.3.2, the effects of the at-grade main roads construction appear early, soon after a relatively small investment.

The difference in the degree of economic viability between the expressway and the bus-way projects is not significant. Considering the investment size (the investment costs of the bus-way projects are less than 1/4th of those of the expressway), the bus-way projects deserve to be studied further in relation to their costs, routes, implementation schedule, and social viability.

3) Evaluation by Implementation Period

The flows of cost and benefit of Project Group 1 (projects completed within 1992 to 1996), Project Group 2 (1997 to 2001), and Project Group 3 (2002 to 2006) are shown in Figures 13.3.5 to 13.3.7, respectively.

The benefit curve in Figure 13.3.5 reaches its peak in 1997 (the following year after the completion of all projects scheduled to be finished within the 7th Plan period), and thereafter shifts to a declining course. The cost curve, on the other hand, has its peak in 1994 (the middle year of the 5 year period), and after disbursement of the investment is completed in 1996, remains horizontal from 1997 through 2006 accounting for the constant annual maintenance costs.

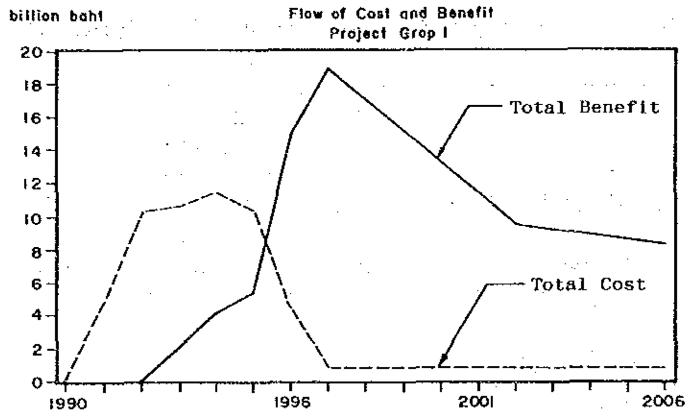


Figure 13.3.5 Flow of Cost and Benefit
- Project Group I -

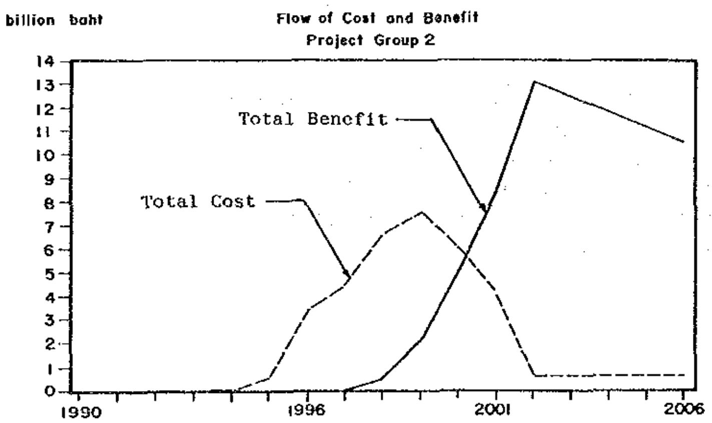


Figure 13.3.6 Flow of Cost and Benefit
- Project Group 2 -

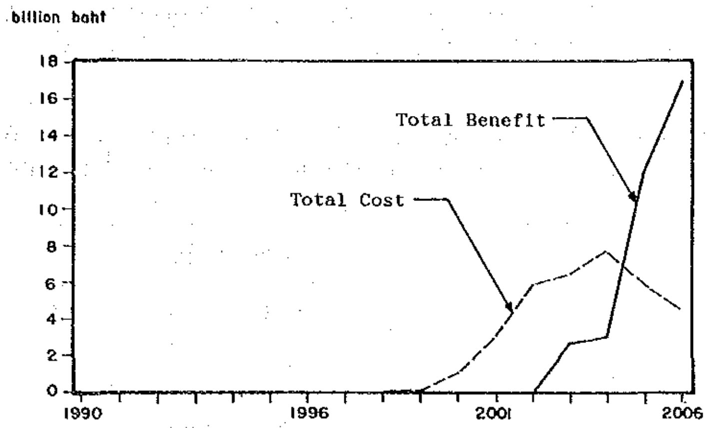


Figure 13.3.7 Flow of Cost and Benefit
- Project Group 3 -

The other two flow curves have the same pattern, although the curves after 2006 are not shown.

The reason why the benefit curve of each project group has its peak in the year following the last year of the respective plan period and then starts declining is that through the plan period the VOC decreases from the "without" case level in proportion to the opening of new roads but after the finishing of road construction planned during the period the difference of VOC between the "without" case and the case concerned gradually diminishes.

Table 13.3.6 shows the evaluation indicators of each project group.

Table 13.3.6 Evaluation Indicators of Project Group

	Project Group 1	Project Group 2	Project Group 3
NPV (million Baht)	16800	11021	8525
B/C	1.6	1.8	2.3
IRR(%)	21.2	23.7	30.1

Each project group is considered to be economically feasible according to the table. Project Groups 1 and 2 show almost the same values for the B/C and the IRR. Corresponding values of Project Group 3 are relatively high. However, these high figures are considered to be the fruits of the preceding investments. Supposing that only Project Group 3 projects and the rail transit projects are added to the existing network by 2006, the savings in the VOC are observed to be very small.

Table 13.3.7 shows the changes in traffic conditions by implementing the road masterplan.

Table 13.3.7 Change in Traffic Conditions by Implementation of Road Masterplan

	Road Network			
	1989	1996	2001	2006
Without Masterplan				
Average Congestion Ratio	0.904	1.648	1.983	2.213
Average Speed (Km/hr)				
Trunk Road	8.05	5.07	4.90	4.78
Expressway	11.39	5.90	5.57	5.14
Bus-way	-	-	-	-
With Masterplan				
Average Congestion Ratio	-	1.064	1.069	0.900
Average Speed				
Trunk Road	-	6.81	6.41	7.64
Expressway	-	7.20	7.73	11.62
Bus-way	-	7.21	8.14	23.30

If no new roads were to be constructed from now through 2006, the average congestion ratio would double to over 2 and correspondingly the average vehicle speed on the trunk roads and the expressways would slow down to half the present values.

Even if the road masterplan is implemented as scheduled, the traffic conditions of the study area will become a little worse than at present during the 7th and the 8th Plan periods. On the 2006 network, the traffic conditions will finally recover to the existing levels.

The implementation of only Project Groups 1 and 2 will not be enough to alleviate the traffic congestion and obtain an average vehicle speed level which can make as much savings in VOC as in the case of implementation of all Project Groups 1, 2, and 3 by 2006.

CHAPTER 14

RECOMMENDATIONS

14. RECOMMENDATIONS

Traffic problems in Bangkok are already very serious, and will become even more serious in the future, unless fundamental measures are properly taken. Direct and indirect traffic costs are almost equivalent to 20% of Bangkok's gross regional product, incurred through the prolonging of commuting hours, environmental deterioration, and discouragement of investments and tourism. One of the major factors which contribute to this situation is the deficiency in urban transportation system, particularly road and road transport.

14.1 Proposed Transportation Network Development Programme

In order to meet the future transportation demand of both private and public modes at a certain level of services, the study revealed that a package of road projects, comprising expressways (a total of 184 km), segregated bus-ways (121 km), at-grade main roads (599 km) and distributors (56 km specifically identified only in and around the city centre) has to be implemented by year 2006, in addition to the development of the extended LRT system (91 km) and elevated Northern Line of SRT (45 km). All these projects are economically viable. However, it is noted that they have to be implemented after due consideration of projects interaction and proper scheduling.

The financial requirements of the proposed projects are approximately 240 billion Baht during the 17 year period between 1990 and 2006.

Table 14.1.1 Investment by Sector and by Period

(million Baht)

Sector	1990-1996	1997-2001	2002-2006	Total
Expressway	30906	21011	18672	70589
At-grade main road	16787	9413	12726	38926
Bus-way	11217	4313	-	15530
Railway project	13621	40918	60713	115252
Total	72531	75655	92111	240297

To strengthen the expressway network, it is essential to complete the circumferential section and extend radial sections along the major corridors. The existing FSE, on-going SSE and committed Ekkamai-Ram Intra will form an integral part of the entire system. Toll roads and expressways of different agencies should be properly connected and toll collection be coordinated. Provision of adequate access and links with at-grade roads is also very important.

In the public transport system, it is recommended that the currently promoted three LRT lines be extended further to meet the expected demand increase in the suburban areas in the north, southeast and west. Along the northern corridor where the present and future demands are the largest, the expansion of the commuter services of the SRT and its elevation are a promising option.

Extensive bus-ways have been proposed in this study. Although the engineering aspects have not been fully investigated and actual application cases are very limited, it is considered that bus-ways will be practical and effective means of improving the public transportation situation quickly without any sizable investment except for the infrastructure. Existing bus fleet and management capabilities can be readily used. It is expected that the bus-ways would strengthen the integration of LRT and conventional bus system and make it possible to introduce new higher standard bus services. With coordinated operation of these public transport modes including, for example, through-ticketing, common fare system, and improved transfer function at mode interchange locations, the development of an affective and competitive public transportation system can be encouraged. It is recommended to conduct more detailed study on bus-ways and bus operation.

Particularly high economic returns are expected from the implementation of the at-grade main road (primary and secondary roads) and distributor projects. They are also very important to support various elevated transportation infrastructures. Although difficulties are experienced in developing the at-grade roads, especially in the inner areas due to objections of the people, adjustment of various rights, etc., the Government should identify ways to accelerate the development of these roads, through the improvement of financial, institutional and administrative systems.

In order to implement the proposed programme without delay, the following particular aspects should be duly considered.

(a) Expansion of financial sources

The Government revenue will increase as the growth of the Thai economy is expected to continue in the foreseeable future. Therefore, the Government should not only give budgetary priority to the development of the metropolitan transportation sector but also should consider investing in this sector with additional funds to be raised on the guarantee of future revenue.

In addition, the expansion of financial sources should be sought, by such means as enforcing the principle either directly or indirectly, that the creators of traffic congestion and the beneficiaries of traffic convenience should bear the cost. Such direct means may include, for example, the introduction of fee-charging facilities and area cordon systems, while indirect means may be in the form of administrative actions such as raising automobile tax, gas tax, or other taxes.

While increasing the Government budget for the development of infrastructure, innovative project implementation methods to enhance investment efficiency must be examined. Profitable projects in need of private know-how may be implemented by the BOT method, for example. Already, Bangkok has many transportation projects being considered for implementation and operation by the private sector. Their success simply depends on profitability although transportation projects are generally ranked lower in profitability. In view of this, it is recommended to examine the possibility of packaging transportation projects with such high profitability projects as residential development around the project sites and commercial development at the transportation nodes.

In general, the development of transportation facilities will increase land prices in and around the service area. Measures to return such economic profits back to the development fund should be established as a governmental system, whenever feasible. These measures may include a land re-adjustment system similar to the one in effect in Japan, a direct beneficiary payment system comparable to ones effective in Central and South America (the system called "Valorization"), or any other pertinent means.

(b) Land acquisition

Urbanization in the suburbs of Bangkok has been rapidly progressing in recent years. The procurement of land for traffic facilities will become more and more difficult, or even impossible in extreme cases, as urbanization progresses. Accordingly, for the construction of roads and railways, land procurement by purchase or exchange should be started as early as possible when the construction is decided, even if such construction is a long way ahead.

For a project whose construction and routes have been determined, an administrative order should be examined to prohibit new buildings or the like within the right of way even if on private property.

14.2 Proposal on Traffic Policy and system

1) Demand control policy

Since the development of transportation facilities in the city centre area is physically limited, an unrestricted traffic influx into that area will ultimately result in an inability to meet demand. Consequently, the task of urban transportation development in the metropolitan area is bound to shift gradually from facility construction to efficient facility utilization. In this sense, it becomes more important to study policies and measures to manage, control, and guide the demand.

The maximum utilization of existing facility must be pursued through adequate control of traffic. Equally significant are the installation of more traffic signals, coordinated signal control along trunk roads, expansion of ATC areas, and augmentation of driver information systems.

For the efficient use of limited transportation space, users of private car and taxi should be encouraged to shift to bus and railway. In view of a strong tendency for passenger car use, this shift is not an easy task. The private-mode traffic should be discouraged on one hand, and every effort should be made to improve the quality of public transportation service on the other.

Basically, it is essential to control the incoming trips into the city centre. This can be achieved by the decentralization of urban functions and the realization of a poly-centric city structure. Equally important will be a policy to develop local cities as a means of inhibiting population influx into the metropolitan area. Thus, the metropolitan traffic plan should be implemented in a much longer perspective and in a more drastic manner in close relation with the urban and regional development plans.

2) Need for total urban transportation policy and planning

It is obvious that complex urban transportation problems cannot be settled by any single means. Any urban transportation policy and plan must be established with a versatile and coordinated approach, involving all the related urban development plans, road plans, railway plans, public transportation plans, and traffic control plans. If each plan is advanced individually in isolation of the others, the lack of coordination will result in low investment effectiveness.

To coordinate the policies and measures of various government offices, it is necessary to have a higher-ranked decision-making authority. Currently, Bangkok has a number of ad-hoc urban transport committees composed of representatives from related government offices to handle specific issues. It might be thus appropriate to study the possibility of nominating one of these committees as a standing committee endowed with the authority of coordination. For the standing committee to make a reasonable decision, it is essential to organize a powerful technical group of planning specialists to support the committee.

Information useful for the urban traffic planning of Bangkok is available from various sources. Items of such information should be collected at an appropriate institution to formulate an urban transport data bank. This data bank should cover various data, such as the SIMR data base of this study, daily traffic volume and public transportation statistics available from the ATC system, and automobile statistics for use by respective government offices.

3) Re-organization of bus routes and the development of transfer points

The introduction of railway and bus-way systems is a realistic and promising means of inducing travelers to use the public transportation system. The introduction of this new traffic mode, however, will not gain public acceptance unless it is fully equipped with essential traffic conveniences, i.e., comfort and rapidity in transport. It is also indispensable to develop suitably located transfer points, re-organize bus networks, and provide agreeable pedestrian space.

14.3 Proposed Studies

This study worked out medium to long-term directions of road development. In order, however, to implement the proposals effectively, more concrete plans need to be formulated by conducting the following studies :

(a) Feasibility Study on Transportation Corridor Development: As urban development is aggressively taking place along major transportation corridors, proposed projects will be studied in a package and integrated with urban development.

(b) Feasibility Study on New Ring Road: To meet the medium-term demand and encourage effective urban development, a new ring road between the Middle Ring Road and Outer Ring Road is worth studying.

(c) Feasibility Study on Bus-ways: Stemming from the belief that bus-way will have a strong impact on Bangkok public transportation system, its feasibility should be thoroughly examined on engineering, operational and management aspects.

(d) Feasibility Study on Secondary and Distributor Roads: Development of secondary and distributor roads in Bangkok is determined to be very important not only from the viewpoint of traffic efficiency but also because of its positive effects on urban and community development.

(e) Study on Transportation Transfer Points: The future urban transportation system in Bangkok will be composed of various transportation modes such as rail transit systems, bus-ways, and roads. To encourage the integration of these modes within an effective urban transportation system, transfer points where passengers terminate or transfer should be properly developed.

(f) Study on Coordination of Elevated Facilities: Components of the proposed elevated transportation system intersect at many locations. In order to use the air space effectively and preserve urban aesthetics and amenity, a study is necessary to determine the planning rules and principles for the development of facilities at these transportation nodes.

(g) Study on Parking: Parking is an area which affects the use and control of private vehicles. Explicit policies should be formulated for parking facilities, spelling out the role and responsibility of the Government and private sector, design criteria, fare setting, etc.

(h) Study on the Impact Management during Construction Period: Implementation of a large number of proposed projects will continuously have an adverse affect on the urban traffic flow. To minimize the negative impact, a separate traffic management system plan needs to be formulated which can be constantly adjusted according to the changes in construction schedule and magnitude of the projects.

TABLES, FIGURES AND ABBREVIATONS

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LIST OF ABBREVIATIONS

ROAD PLAN

BB	Budget Bureau
BCD	Building Control Division
BMA	Bangkok Metropolitan Administraion
BMR	Bangkok Metropolitan Region
BMTA	Bangkok Mass Transit Authority
BTS	Bangkok Transportation Study in 1975
BTSS	Bangkok Transit System Study in 1986
B/C	Benefit Cost Ratio
CAB	Cabinet
CCSD	Construction Control and Supervision Division
CMD	Construction and Maintenance Division
CMRT	Committee for the Manegement of Road Traffic
CPD	City Planning Division
DD	Design Division
DLT	Department of Land Transport
DOH	Department of Highway
DPP	Department of Policy and Planning
DPW	Department of Public Works
DTCP	Department of Town and Country Planning
ETA	Expressway and Rapid Transit Authority of Thailand
ETO	Express Transportation Organization of Thailand
FSE	First Stage Expressway
GDP	Gross Domestic Product
GRP	Gross Regional Product
HD	Harbor Department
HRT	Heavy Rail Transit
KSS	Elevated Toll Road above Klong Saen Saep
LRT	Light Rail Transit
LTCB	Land Transport Control Board
LTPC	Land Transport Polocy Committee
MOC	Ministry of Communication
MOF	MInistry of Finance
MOI	Ministry of Interior
MPB	Metropolitan Plice Bureau
MSTE	Ministry of Science, Technology and Energy
NESDB	National Economic and Social Development Board
NPV	Net Present Value
NSC	National Safety Council
OCMRT	Office of the Committee for the Management for Road Traffic
OFP	Office of Fiscal Policy
ONEB	Office of the National Environmental Board
OPM	Office of the Prime Minister
OPP	Office of the Policy and Planning
OPS	Office of the Permanent Secretary (BMA)
PCU	Passenger Car Unit
PD	Police Department
PT	Person Trip
PWD	Public Works Department
RWLD	Right of Way and Land Acquisition Division
SRT	State Railway of Thailand
SSE	Second Stage Expressway
STTR	Bangkok Metropolitan Short Term Transport Review
TD	Treasury Department
TED	Traffic Engineering Division
TPD	Traffic Police Division
TSES	Third Stage Expressway System
TTC	Travel Time Cost
VOC	Vehicle Operationg Cost

ATC SYSTEM

ATC	Area Traffic Control
BMA	Bangkok Metropolitan Administration
CCU	communication Control Unit
DET	Vehicle Detector
ETA	Expressway and Rapid Transit Authority of Thailand
FHWA	Federal Highway Administration
FSR	Frequency Shift Keying
GRM	Synchrinous Response Mode
MDF	Main Distribution Frame
MEA	Metropolitan Electricity Authority
OCMRT	Office of the Committee for the Management for Road Traffic
PCM	Pulse Code Modulation
PP	Pre-Processor of Vehicle Detector
PSK	Phase Shift Keying
SCAT	Sydney Highway Administration
TOT	Telephone Organization of Thailand
TTC	Travel Time Cost
TTR	Terminal Transmitter-Receiver
UTCS	Urban Traffic Control System
VA	Vehicle-Actualed
VOC	Vehicle Operating Cost

CUD SYSTEM

AASHTO	American Association of State Highway and Transportation Officials
ANSI	American National Standard Code for Pressure Piping
BMA	Bangkok Metropolitan Administration
CAB	Cable Box
CAT	Communication Authority of Thailand
CBD	Central Business District
CMD	Cubic Meter per Day
CUD	Common Utility Duct System
DDS	Department of Drainage and Sewerage, BMA
EGAT	Electricity Generating Authority of Thailand
ETA	Expressway and Rapid Transit Authority of Thailand
KV	Kilovolt
MEA	Metropolitan Electricity Authority
MTS	Mass Transit System
MVA	Megca-Volt Ampere
MWA	Metropolitan Water Works Authority
NESDB	National Economic and Social Development Board
PTT	Ptroleum Authority of Thailand
PVC	Polyvinylchloride
SRT	State Railway of Thailand
TOT	Telephone Organization of Thailand

JICA